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JACQUES ROHAULT AND THE NATURAL SCIENCES

submitted by

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PREFACE

In writing this dissertation I have aimed at giving a description and analysis of the career of Jacques Rohault and his work in the natural sciences. More specifically, I have attempted to identify the sources of inspiration of his Traité de Physique.

Most historians of science have paid little more than casual homage to Rohault's work as a synthesiser and propagandist of Descartes' natural philosophy. A few enthusiasts, however, have recognised that the Traité de Physique and the different versions of Samuel Clarke's notes to its Latin and English translations were the arena of a Descartes-Newton contest in the late seventeenth and early eighteenth centuries. I sought to contribute to an understanding of this contest by examining how Rohault's Traité came to be written. Another outstanding contributor to Rohault studies was Paul Mouy, whose book, Le Développement de la Physique Cartésienne,[1] first aroused my interest and encouraged me to view Rohault's work in its mid-seventeenth century context. In addition, my debt to a host of other scholars is great. I hope that my footnotes and list of sources will serve as a partial acknowledgement of that debt.

The work is divided into three parts. Part one is introductory and is an attempt at an objective description of Rohault's career. It gives an account of his early life and education, defines the limits of his success and describes his scientific publications. The

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[1]Paris, 1934.

second part, on Rohault's concept of science, is an internalist analysis of the characteristic features of the Traité de Physique. It is evident, here, that Rohault's principal aim was to find experimental data to corroborate Descartes' all-explanatory system of the physical world. Part three, in which an externalist method is used, is a more subjective interpretation inspired by the belief that French natural philosophers of the mid-seventeenth century were conditioned by the whole weight of their culture. Instead of giving a panoramic description of that culture I have chosen to examine the part which is important to an understanding of Rohault. To support my argument I have conducted a detailed examination of how Théophraste Renaudot, the Académie des Sciences, Jacques Rohault and French cartesians were influenced by different types of censorship, and in this way place Rohault in a larger historical context.

My thanks go to the Ministry of Education, Northern Ireland and to the Centre National de la Recherche Scientifique for the money which they gave me to undertake research in this subject. I should also like to express my gratitude to the Directors, Trustees, archivists, librarians and staff-members of the following institutions; the Bibliothèque Nationale, Archives Nationales, Minutier Central, Archives de l'Académie des Sciences, Archives de l'Université, Bibliothèque Ste. Geneviève, Bibliothèque Victor Cousin, Bibliothèque Municipale d'Avignon, Bibliothèque Inguimbertine, Carpentras, Bibliothèque Municipale de Chartres, Bibliothèque Municipale de Clermont-Ferrand, Bibliothèque Municipale de Poitiers, the British Museum, University Library, Cambridge and the University Library of the U.W.I., and to say a special thank you to Mme. Jurgens of the Minutier Central for her help and encouragement, to the archivist and librarians at the Archives Départementales de la Somme, Bibliothèque Municipale d'Amiens and Archives Municipales de Honfleur, who promptly answered my letters and sent me photocopies of the material I requested.

Finally, I wish to thank Dr. David Buisseret, Dr. John Roach and Dr. Frederic Stanwood for their helpful comments during the final stages of the writing of my thesis, Mrs. Pat Buisseret, who did the typing, and last but not least, my supervisor Dr. Michael Hoskin, for his long-lasting patience, tolerance, criticism and encouragement.

This dissertation is the result of my own individual work and no part has been carried out in collaboration with anyone else.

Trevor McClaughlin

CONTENTS

ABBREVIATIONS

O.D.	Oeuvres de Descartes, edited by C. Adam and P. Tannery, 13 vols., Paris, 1897-1913.
O.H.	Oeuvres Complètes de Christian Huygens, 22 vols., La Haye, 1888-1950.
B.N.	Bibliothèque Nationale, Paris.
A.N.	Archives Nationales, Paris.

PART I

JACQUES ROHAULT: LIFE AND WORK

CHAPTER I

EARLY YEARS AND EDUCATION

Jacques Rohault was born in Amiens in 1617(?)[1], the son of Antoinette de Ponthieu and a successful wine merchant, Ambroise Rohault. He died in Paris in December 1672[2] a renowned teacher of mathematics and exponent of cartesian philosophy.

Adrien Baillet, in his Vie de Descartes, described Rohault as being "d'assez médiocre mais fort honnête famille"[3], or as having come from a background of respectable, provincial, middle-class catholicity. This claim is verified by material available in the Archives Nationales and the Archives Départementales de la Somme.

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[1]The date of Rohault's birth is uncertain. I have chosen the year 1617 because Nicolas Lienard wrote in the Journal des Sçavants, 9 Mai 1695, that Rohault was 55 years old when he died in 1672 and because in A.N. Actes des Insinuations, 6 Oct. 1644, Y184 fol. 99vo, he is described as the eldest son of Ambroise Rohault. See the family-tree in Appendix 1.

[2]A.N. Minutier Central, Etude 39, Liaisse 127, L'Inventaire de Jacques Rohault, 27 Fév. 1673.

[3]A. Baillet, Vie de Descartes, 2 vols., Paris, 1691, Pt.II, Livre VII, ch.iii, p. 241.

His grandfather, Jacques Rohault l'âîné, was registered as "bourgeois d'Amiens" on 14th May, 1608.[4] His father became "marchand mercier d'Amiens" on 16th April, 1619,[5] and in a Registre de la Fabrique de St. Germain was described as "Ambroise Rohault bourgeois de cest ville d'Amyens, marguiller de l'Eglise de Dieu et Monsieur de St. Germain".[6] Two of his brothers were priests. Germain was Chapelain de Dompmart and Canon of St. Quentin; Jacques the younger became Canon of St. Quentin when Germain died.[7] In 1650, when Rohault married Nicole Filassier, he married into a middle-class Parisian family.[8] In 1664, when he remarried, this time to Geneviève Clerselier, the signatories to the marriage contract on his behalf were all 'marchands bourgeois'.[9]

Rohault's family was of substantial means.[10] In 1627, grandfather Jacques Rohault l'âîné gave 1,000 livres to his son Jacques (Rohault's uncle), when he married Marguerite Lescuyer.[11] In 1644,

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[4]Archives Départementales de la Somme, Fichier Guerlin.

[5]loc. cit.

[6]Cited in M. Bazot, "Note sur Jacques Rohault", Bulletin de la Société des Antiquaires de Picardie, IX, 1865-7, p. 376.

[7]A.N. Minutier Central, 34:119, Contrat de Mariage, 8 Jan. 1650. ibid., 39:159, Compte Rendu à Marie Rohault, 9 Jan. 1685.

[8]A.N. Minutier Central, 34:119, Contrat de Mariage, 8 Jan. 1650. See Appendix 2.

[9]A.N. Minutier Central, 39:110, Contrat de Mariage, 8 Sept. 1664.

[10]The evidence for this statement occurs in isolated references in notarial minutes.

[11]A.N. Minutier Central, 87:456, Contrat de Mariage, 15 Dec. 1627 (to be found between 20 and 22 Nov. 1627).

Ambroise Rohault gave his son Jacques, mathematics teacher, five "loges", three in St. Germain des Prés and two in the Halles of St. Denis.[12] Before 1650, Rohault borrowed nine thousand livres from his brother Germain[13] and in 1682, Marie, his only daughter, inherited one hundred and fifty livres from Germain, in execution of his will of 1679.[14] Rohault's own income[15] came from what he earned as a mathematics teacher[16] and what he gained as an 'officier'[17] and 'rentier'[18] and from his marriage to Nicole Filassier[19] and Geneviève Clerselier.[20] When he died in 1672, he left Marie certain

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[12] A.N. Actes des Insinuations, Y 184, fol. 99vo.

[13] A.N. Minutier Central, 99:214, L'Inventaire de Nicole Filassier, 19 Juin 1663.

[14] A.N. Minutier Central, 39:159, Compte Rendu à Marie Rohault, 9 Jan.1685.

[15] Details of Rohault's complicated financial history may be obtained by working from the 'Titres et Papiers' of his own inventory and that of Nicole Filassier.

[16] The only information which I have discovered on this is reported in Chapter II, p. 34.

[17] A.N. Minutier Central, 34:118, Vente d'office, 11 Dec. 1649. The office was Inspector of Wines, "Commissaire controlleur Juré Moulleur, Compreur, Cordeur, Mesureur et vissitteur de boire de ceste ville faulxbourgs et banlieus de Paris." Rohault personally gained little financial benefit from the transaction. It was rather an insurance policy for the children of Nicole Filassier and her first husband, Jean Godard.

[18] A.N. Minutier Central, 39:117, Transport de rente, 28 Avril 1668. The 'rente' on the "trois millions des gabelles" which Rohault bought from Nicolas Boucher, Sieur de Royaumont, was 1115 livres 19 sols per annum.

[19] Nicole Filassier owned a house and shops "adossées contre les murs du pallais devant l'Eglise St. Barthelemy", a shop "adossée contre les murs du coste de l'horloge du Pallais", a house at 16, Popincourt, and a little house 16, sur le Quay du grand cours d'eau. The house at 16,Popincourt was let for 200 livres and the one at 16, sur le Quay..for 150 livres per annum.

[20] Geneviève's dowry was 12,000 livres.

properties of unspecified value[21] and belongings valued at thirteen thousand livres.[22]

Little evidence exists for Rohault's early life and education. Gence, in the Biographie Universelle, suggested that he received a Jesuit education in his home town before being sent by his father to Paris to complete his studies.

The Jesuits effectively took over diocesan education in Amiens in 1608. By letters patent of 1604 they were given permission to establish

> ... un collége en ladite ville d'Amyens capitalle de nostre province de Picardie, composé de tel nombre de personnes d'icelle société qu'ils verront y estre nécessaire pour le service divin et instruction de la jeunesse aux bonnes lettres tant d'humanités, philosophie, que théologie aux classes, règles et formes dont ils ont accoustumé user ès colléges qu'ils ont auxdits villes de nostre royaume... .[23]

In 1608 lessons commenced. At first, only the five classes of humanities were taught but a theology class and an entire course of philosophy was promised as soon as the college was wealthy enough.[24]

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[21] The "loges boutiques à la foire St. Germain" and the "trois millions des gabelles" were not valued in Rohault's inventory.

[22] This includes 1,050 exemplaries of Rohault's Traité de Physique valued at 2,400 livres. Later, Geneviève Clerselier sold Desprez the publisher and bookseller, the 'privilège', letters patent and exemplaries remaining in her possession for 12,400 livres.

[23] Cited in F.I. Darsy, Les Ecoles et les Colleges du diocèse d'Amiens, Amiens, 1881, p. 192.

[24] see L'Abbé Dubourguier, Grandes Ecoles et Gens d'Eglise au Diocèse d'Amiens sous l'Ancien Régime, Amiens and Paris, 1904, pp. 455-8.

Unfortunately most of the material for the early history of the Jesuit college in Amiens is concerned with its administrative rights and the support given by the town authorities.[25] What little information there is on books in the library, comes from mid-seventeenth century documents. An inventory in 1661, of the Maison des Capettes, showed that books in the library consisted of Homilies, Greek grammars, the _Offices_ of Cicero, the Commentaries of Caesar, six comedies of Terence and the _Apophtegms_ of Plutarch along with those necessary for religious edification: a Bible, an Antiphoner, a Sermonary, "un livre de la vie parfaite du Père Le roux" and "_Les Fleurs des Saints_".

Whether or not Rohault received any mathematical or 'scientific' education there, is open to debate. Father Dainville has recently shown how up to date the Jesuits were, in making provision for the teaching of the mathematical sciences from as early as the mid-sixteenth century. Yet, from a survey of the Jesuit colleges in specific areas of France, he concludes that it was only in the second half of the seventeenth century that the small number who were interested were successful. He does not mention the college of Amiens.[26]

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[25] see _L'Inventaire Série D_ of the Archives Départementales de la Somme by Georges Durand, T.IV, Amiens, 1897. The present archivist informed me that, to the best of his knowledge, there were no archives for the books used and the pupils and teachers who attended the Collège d'Amiens in the first half of the 17th century. A.N. M 245 has some material on the college but it dates from the 18th century.

[26] see R.P.F. Dainville, "L'Enseignement des Mathématiques dans les Collèges Jésuites de France du XVI^{e} au XVIII^{e} siècle", _Revue d'Histoire des Sciences_, VII, 1954, pp. 6-21, 109-23. idem., "Effectifs des collèges et scolarité aux XVII^{e} et XVIII^{e} siècles dans le Nord-Est de la France", _Population_, X, 1955, pp. 455-88.

However, from the Ratio Studiorum et Institutiones Scholasticae Societatis Jesu of 1586 and 1599,[27] it is possible to describe the type of schooling Rohault should have received had he attended the Jesuit college.

In the three grammar classes, he would have been grounded in Greek and Latin grammar from a study of selected works of classical masters such as Cicero, Seneca, Ovid, Catullus, Virgil, St. Chrysostom, Aesop and Agapetus. In the rhetoric class, he would have studied the books of rhetoric of Cicero and Aristotle by commenting on the style and syntax and learning by repetition. He would have studied the works of history, poetry and oratory of Demosthenes, Thucydides, Homer, Hesiod and Pindar. In the humanities class, he would have gleaned what he could from the language, erudition and eloquence of Cicero, Caesar, Sallust, Livy, Virgil, Ovid, Pliny, Cyprien, Plutarch and Saints Chrysostom and Basil.[28]

If he had followed a three year philosophy course,[29] he would have studied, in the first year, logic and ethics based on texts from Aristotle, Toleto and Fonseca; and in the second year, physics and mathematics from Aristotle's Physica, De Caelo, De Generatione Animalium, Book 1, and the Elementa of Euclid "in the utilitarian

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[27] reprinted in Monumenta Germanicae Paedagogica, vol. V, Berlin, 1887.

[28] ibid., 1599, Regulae Professoris Rhetoricae; Regulae Professoris Humanitatis; Regulae Professoris Supremae Classis Grammaticae, pp. 398-442.

[29] ibid., 1586, De Studio Philosophiae, pp. 129-38, 1599, Regulae Professoris Philosophiae, pp.332 ff. and Regulae Professoris Mathematicae, p. 348.

manner after Clavius". In the third year, the Aristotelian emphasis would have been further stressed by a study of Aristotle's De Anima, Metaphysicorum and De Generatione Animalium, Book 2.

Throughout his school career, he would have received whatever instruction and training his teachers thought necessary for his spiritual health and religious edification:

> Feratur autem ejus peculiaris intentio tam in lectionibus, cum si occasio obtulerit, quam extra eas, ad teneras adolescentium mentes obsequio et amori Dei ac virtutum, quibus ei placere oportet, praeparandas.[30]

It is stated in certain Biographical Dictionaries[31] that Rohault excelled at school. The case for this may simply be his success in later life. At any rate, we have not found any evidence to substantiate the claim.

It is also claimed by certain Biographical Dictionaries and by Saverien, in his Histoire des Philosophes Modernes,[32] that Rohault was sent to Paris by his father to complete his studies but that he spent some time visiting workshops, advising and learning from craftsmen before he began his philosophy course at the University. There is no evidence to give the precise date of Rohault's arrival in Paris or to confirm that he travelled the workshops at this time.

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[30] ibid., 1599, Regulae communes Professoribus classium inferiorum, p.378.

[31] see, for example, the Biographie Universelle, nouv. édit., Paris, n.d., XXXVI, art. Jacques Rohault; see also l'abbé Daire, Histoire Littéraire de la ville d'Amiens, Paris, 1782, pp. 197-202.

[32] A. Saverien, Histoire des Philosophes Modernes, 8 vols., Paris, 1773, VI, 6.

Similarly, we have been unable to ascertain the names of his teachers or the name of the college which he attended.[33] What we do know is that he was in Paris in October 1644, living in the Rue de la Coutellerie.[34] We know too that, in December 1646, Jacques Rohault of Amiens became Master of Arts of the University of Paris[35] and that throughout his life he showed an interest in and knowledge of the techniques of artisans and craftsmen.

Claude Clerselier, in his biographical sketch of Rohault's career, is more specific, stating that Rohault, endowed with mechanical inventiveness and imagination, loved to wander through all sorts of workshops, learning from and advising the craftsmen.[36] A reference in his own Entretiens sur la Philosophie suggests that his mechanical interest had manifested itself at an early date. In a conversation on the Beast-Machine controversy, he refers to "certains automates que j'ay veu dans ma jeunesse et que representoient fort bien et fort artistement divers animaux".[37] In his Traité

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[33] My search for details of Rohault's university career was unsuccessful. See Appendix 4 for a list of sources consulted.

[34] A.N. Acte d'Insinuation, Y 184, fol. 99vo. Rohault lived in the Rue de la Coutellerie (1644), on the Pont au Changeurs (1646-50), l'Isle du Pallais (1651) and Rue Quincampoix (1655-72).

[35] B.N. Fonds Latin, 9154, fol. 77. "Anno domini millesimo sexcentesimo quadragesimo primo die vigesima Decembris fuit graduatus in Artibus Mag. Jacobus Rohault Ambianus."

[36] J. Rohault, Oeuvres Posthumes, Paris, 1682, preface, not pag.

[37] B.N. Fonds Français, 14837, fol. 272ro; J. Rohault, Entretiens sur la philosophie, Paris, 1671, p. 151.

de Physique and Oeuvres Posthumes it is obvious, from the 'mechanical' examples which he uses to 'demonstrate' his physical theories, that he is familiar with the different sorts of materials, instruments and techniques of various craftsmen: metals, precious stones, glass, dyes, balances, levers, pulleys, instruments for land surveyance, the arts of the goldsmith, jeweller and civil and military engineer.[38]

In 1649, Rohault came into contact with the Parisian wine-manufacturing industry and trade when he bought the office, 'Inspector of wines of the town, suburbs and outskirts of Paris', from Nicole Filassier. In 1650, he married Filassier whose relatives represented a cross-section of the merchant and artisan community: masons, goldworkers, jewellers, wine-merchants and pedlars.[39] In 1663, the "Inventaire du deffunt N. Filassier" states that the "communité des biens" existing between her and Rohault had in its possession "un petit tour de fer avec une cassette ou sont plusieurs outilz d'horlogerie".[40] Rohault states that they are owed fifty-five livres by M. Fourdrinyer, maker of mathematics instruments, money which Rohault had advanced for instruments he did not receive. In 1673, the goods itemised in his own inventory, including the rich collection of silverware, the valuable watches and pendulum clocks made by Claude Raillard, the instruments he used in his conferences and for his experiments, magnets, mirrors, microscopes, compasses and glass

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[38] See Appendix 2.

[39] See Appendix 2.

[40] A.N. Minutier Central, 99:214, Inventaire de Nicole Filassier, 19 Juin 1663.

tubes, suggest that some sort of relationship, even if it was only a commercial one, existed between Rohault and craftsmen till the time of his death. It was normal for someone of a mechanically inventive bent to have some sort of contact with craftsmen. The example of two of Rohault's contemporaries, Pierre Petit and Christian Huygens, bears witness to this.[41] Furthermore, Rohault himself testifies to the benefit he received from conversations with artisans and to his admiration and respect for their inventions.[42]

In 1643 or 1644 Rohault began his two-year philosophy course at the University of Paris. The University was neither the most enlightened nor the most progressive of institutions. Beset by factional strife, interfaculty squabbles and disputes with the Jesuits, it remained stifled by its own dogmatism and conservatism. Religiously intolerant, systematically suppressing liberty of thought by controlling the publication of books, the institution insisted on its peripatetic courses being taught in Latin.

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[41]Pierre Petit (1598-1677), ingénieur et géographe du roi, intendant général des fortifications, F.R.S., astronomer and mathematidian, worked with artisans in his own home. Huygens was renowned at Montmor's Academy for his work on pendulum clocks and "la machine du vuide" and for his contacts with "bons ouvriers".

[42]J. Rohault, Traité de Physique, Paris, 1671, preface not pag.

Only Roman Catholics were admitted. Article three of the 1598 Statutes states:

> Nemo a gymnasiarchus in collegia admittatur et hospitio excipiatur qui religionem catholicam et apostolicam non amplectatur. Exteri qui adeunt collegia studii causa, moneantur ne de nova religione inter condiscipulos aut alios omnino conferat. Quod si neglexerunt, aditur collegi prohibeantur.[43]

In 1638, Brunier, a Protestant, was expelled from the Medical Faculty and a measure taken to deprive of their degrees those who did not profess catholicism.[44]

In 1624 fourteen anti-Aristotelian theses by Jean Bitault, Antoine de Villon and Etienne de Clave were condemned by the Theological Faculty and the Parlement of Paris.[45] All three men were exiled from the jurisdiction of the Paris Parlement and forbidden to teach philosophy in any university, forbidden to dispute, publish or sell their theses under penalty of corporal punishment. It was further decreed that all persons should be forbidden, under penalty of death, to hold or teach any doctrines against old and approved authors or to engage in any disputation except those which should be approved by the doctors of the Faculty of Theology.

In 1625, Henry Khumrath's book, The Amphitheatre of the Only True Eternal Wisdom, Christian, Cabalistic, Divine Magic also Physical Chemical..., was condemned on the grounds that it was full

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[43] Statuta Facultatis Artium, 1598 and 1600. Printed in C. Jourdain, Histoire de l'Université de Paris au XVII^{e} et XVIII^{e} siècles, Paris, 1862-6, Pièces Justificatives, I,3.

[44] Jourdain, Histoire, Pièces Justificatives, LXXXVII, 68.

[45] The material for the next two paragraphs is taken from C. du Plessis d'Argentré, Collectio Judiciorum de novis erroribus, 3 vols., Paris, 1728-36, II, b, pp. 147 ff. See also, L. Thorndike, "Censorship by the Sorbonne of Science and Superstition in the first half of the seventeenth century", J.H.I., XVI, 1955, pp. 119-25.

of impieties, errors and heresies. In 1629, the Curiositez Inouies of Jacques Gafferel suffered the same fate.

The 1598 Statutes regulated the teaching of courses. These were conducted in Latin. Article sixteen states that "Nemo scholasticorum in collegio lingua vernacula loquatur, sed latinus sermo eis sit usitatus et familiarus".[46] In 1612, M. Camus, Principal of the Collège de Tréguier, announced his plans for teaching philosophy in French. He was ordered to either renounce his plans or leave the University. In November of the same year, Germain de Vauchelles, a regent of philosophy at the Collège de Bourgogne, was ordered to stop giving lessons in physics and logic outside the college. As this abuse was widespread and as a large number of unauthorised foreigners were teaching in Paris the University decided that no 'public or particular' courses could be given by anyone who had not matriculated at Paris and who had not obtained the consent of all the doctors of the necessary faculty.[47]

As far as the philosophy course was concerned, students were required to have studied grammar and rhetoric and to know Latin and Greek. Prescribed books were almost exclusively those of Aristotle and his commentators. This Aristotelian basis for the philosophy course was reaffirmed in 1664 by the Mémoire of the Commission set up to enquire into university reform and again in 1671, by decree

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[46] Jourdain, Histoire, Pièces Justificatives, I, 4.

[47] Jourdain, Histoire, Pièces Justificatives, XXXVIII, 40.

of the University General Assembly. Article thirteen of the 1664 Mémoire states that philosophy teachers "s'attacheront principalement a la doctrine d'Aristote..."[48] whereas the 1671 Assembly, at the injunction of Louis XIV, decreed that the old rules should be upheld.

In the first year, in the morning, were studied 'Aristotle's' works on logic; the Isagoge of Porphyrus, the Categoriae and then successively the De Interpretatione, the first five chapters of the Analytica Priora, the eight books of the Topica and finally two books of the Analytica Posteriora. In the evening an explanation of the Ethica was given. In the second year, in the morning, there was a course on Aristotle's Physica and in the evening, the Metaphysica. At six o'clock in the morning, the physical globe and some books of Euclid were studied.[49]

The principal among diverse methods of examination was that of the disputation. In the first year this was held in private, within the confines of the University, without any publicity. In the second year it was held in public. During Lent, an examinee had to prove himself. By means of a verbal discourse, he had to demonstrate and develop a problem in logic or ethics. In June he was examined on all parts of the course.[50]

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[48] Bib. S[te] Geneviève, Mss 277, p. 99. Article 14 continues in the same vein, "Qu'aucun ne puisse estre Professeur en philosophie, sans avoir esté auparavant interrogé sur les principaux traittez d'Aristote par quatre des plus anciens Professeurs de Philosophie...".

[49] Jourdain, Histoire, Pièces Justificatives, I, 5.

[50] loc. cit.

Officially, then, the University was dogmatic and conservative. Unofficially, this may not have been the case. The fact that measures continually had to be taken against those who wished to lecture in the vernacular or to hold courses outside the University, supposes a certain amount of independence and contact with the outside world. Rarely, however, are the doctors and regents who were in contact with the front line of the scientific movement mentioned by name. Hilarion de Coste names a few, 'Messieurs Chastelain...Perreret...de Launay...',[51] who were friends of the indefatigable Minim, Marin Mersenne. Gui Patin, sometime Dean of the Medical Faculty, unashamedly praises Gassendi in his private correspondence.[52] It is as a group that their presence is usually noted in the conference milieu. Théophraste Renaudot, in one of the tracts of his polemical warfare with the Medical Faculty, states that his conferences or "Academie...est l'une des plus belles et plus utiles institutions qu'il ait faites, au jugement mesme de plusieurs de vostre corps",[53] suggesting that members of the Medical Faculty had attended his conferences. Jean Chapelain discloses the

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[51] see the extract from H. de Coste, La Vie de R.P.M. Mersenne, Paris, 1649, in Correspondance du P. Marin Mersenne, pub. Mme. P. Tannery et C. de Waard avec la collaboration de R. Pintard, Paris, 1932, I, XXX-XLIII.

[52] see Lettres de Gui Patin, ed. J.H. Reveillé-Parise, 3 vols., Paris, 1846, II, 216-17, 405, III, 65 et passim.

[53] B.N. Fonds Français 21470, Réponse à l'Examen de la Requeste presentée à la Reine par Theophraste Renaudot. Portée à son autheur Machurat, fol. 45vo.

presence of "des Docteurs de Sorbonne" at the meeting of Montmor's Academy where he had read Huygen's letter explaining the System of Saturn.[54] Likewise, Claude Clerselier, listing the different types of people who attend Rohault's conferences, includes "...Docteurs... Regens, Escoliers".[55]

Nonetheless, it remains true that the position of the professor or regent who was rash enough to publish or publicise any unorthodox view, was a dangerous one. It would appear that the University, in its judicial capacity as guardian of religious orthodoxy, was able to dampen the desire of the young regent who wished to see himself in the van of the new intellectual movement. At any rate, the names of Paris University professors who were leaders in this movement do not spring readily to mind.

The courses consisted mostly of commentaries on Aristotle's natural philosophy and whenever reference was made to contemporaries' views, it was mostly, if not only, to refute them.[56] Nonetheless, the student had been given a groundwork of knowledge from which to work. He came into contact with the new theories and gained some rudimentary techniques for studying.

Rohault, for example, acknowledged his debt to the Ancients.

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[54] O.H., II, Jean Chapelain à C. Huygens, 10 Mai 1658, 174.

[55] Rohault, Oeuvres Posthumes, Paris, 1682, preface, not pag.

[56] see, for example, the philosophy course of Pierre Barbay (d.1668) which was published in 5 vols., Paris, 1675-6. Barbay had taught at the University of Paris for fourteen years. For an 18th century criticism of his work, see B.N. F.Fr. Collection de Picardie 102, Liaisse 1, fols.5-6.

He praised Aristotle for his admonition to use experiments and teach children mathematics. He explained that he learnt much from his examination of Aristotle and Epicurus. On his own book he says, "ceux qui le liront pourront aisément reconnoître que je n'ay rien negligé de ce que les Anciens nous ont appris de bon".[57]

The University, too, may have stimulated Rohault's interest in mathematics. The study of the Elements of Euclid 'in the utilitarian manner after Clavius' finds its echo in two essential characteristics of Rohault's later mathematics treatises: their elementary standard and their emphasis on utility. Consciously or not, French scholars could not help being influenced by the ideas of the Ancients for the curricula of the official organs of education were almost solely based on them.

Another contribution to Rohault's education came from his circle of friends. What evidence exists, suggests that Rohault, in the early sixteen fifties, was a member of the group that surrounded the libertine, fantasist author, Cyrano de Bergerac. Henri Lebret wrote:

> Monsieur Roho...cet illustre mathematicien, qui a tant fait de belles eppreuves physiques, et qui n'est pas moins aimable pour sa bonté et sa modestie que relevé au dessus du commun par sa science, eut tant d'amitié pour Monsieur de Bergerac, et s'interessa de telle sorte pour ce qui le touchoit, qu'il fut le premier qui descouvrit la veritable cause de sa maladie, et qui rechercha soigneusement, avec tous ses amis, les moyens de l'en delivrer...[58]

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[57] Rohault, Traité, preface, not pag.

[58] C. De Bergerac, Histoire Comique ou Voyage dans la Lune, Paris, 1657, Préface by Henri Lebret, not pag.

Lebret in the same text paints brief pen portraits of Cyrano's group of friends who are renowned for their erudition and love of the 'République des Lettres'. Among those who with Rohault advise Cyrano to take a patron at Court, are François de Lignières, the satirical cabaret poet, "dont les productions sont les effets d'un parfaitement beau feu: Monsieur de Chasteaufort, en qui la memoire et le jugement sont si admirables, et l'application si heureuses d'une infinité de belles choses qu'il sait", Gilles Filleau des Billettes, "qui n'ignorait rien à vingt trois ans de ce que les autres font gloire de sçavoir à cinquante", Adrien de la Morlière, "dont les moeurs sont si belles, et la façon d'obliger si charmante; Monsieur le Comte de Brienne de qui le bel esprit respond si bien à sa grande naissance", and the erudite Monsieur l'Abbé de Villeloin, Michel de Marolles.[59]

Some idea of the eclecticism and erudition of those associated with Cyrano de Bergerac may be gleaned from the anonymous preface to the 1662 edition of the Histoire du Soleil. There, the authority of all sorts of philosophers is invoked to support some of the ideas in the text: Lucian for the possibility of people living in the Sun; Apulus, Lactantius, Zeno and Plutarch for a belief in a superior race of spiritual beings; the belief of the Ancients in the ether; Robert Fludd and Descartes for the transparency and 'subtility' of matter as it approaches the Sun; Descartes and the ingenuity of Cyrano for the method of travelling.

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[59] loc. cit.

It has been suggested[60] that the relationship between Cyrano and Rohault was that of pupil-teacher; that Rohault taught Cyrano cartesian physics and was accepted into the group of friends where the daring utopian and critical imagination of Cyrano, drawing on a wealth of eclectic, philosophic and mystical thought, fired their conversations and discussions. This hypothesis rests on the Lebret passage already quoted, on the _Fragment de Physique_ appended to the 1662 edition of Cyrano's _Nouvelles Oeuvres_ and on the cartesian inspiration of the _Histoire du Soleil_. The _Fragment_ bears remarkable affinities with the early part of Rohault's _Traité de Physique_. Parts one and two of the "Idée Générale de Physique" prefixed to the _Fragment_ correspond to the line of argument taken in the text of Parts one and two of Rohault's _Traité_. The _Fragment_ itself bears great similarity to parts of the first eleven chapters of the _Traité_.

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[60] This is putting mildly. Nineteenth and twentieth century editors and critics of the works of Cyrano seem to let their imagination run amok in their examination of Cyrano's friendship with Rohault. P. Lacroix, in his 1858 edition of the _Histoire Comique des Etats et Empires de la Lune et du Soleil_, claimed that Rohault met Cyrano, if not at the Collège de Beauvais where Cyrano studied between 1631 and 1637, then at Gassendi's in the early 1640's. Rohault, he said, was an "élève favori de Descartes", the 'Plato' of Cyrano's _Entretiens Pointus_, author of the prefaces to the _Histoire du Soleil_ and _Fragment de Physique_ in the 1662 edition of _Les Nouvelles Oeuvres_. P.A. Brun made similar claims in _Savinien de Cyrano Bergerac: sa vie et ses oeuvres_, Paris, 1893. F. Lachèvre, in _Les Oeuvres Libertines de Cyrano de Bergerac_, 2 vols., Paris, 1921, while highly critical of Lacroix, nonetheless alleged that Rohault was studying physics while Cyrano was in the army (1639-40), and that he first met Cyrano c. 1645. None of these men cited the source(s) for their references to Rohault. Despite an extensive search I have been unable to find any evidence to substantiate what they have written.

In the Histoire du Soleil, Cyrano, although imaginatively calling on a wide variety of authors and philosophers, pours lavish praise on Descartes in particular. Cartesian explanations for some of the phenomena which Cyrano encounters, run throughout the text. The plenitude of the cartesian world and hence the denial of the vacuum, matter reduced to extension with figure and motion as its only two essential properties, are among those used. Coupled with these ideas is an emphasis on experimental method and mechanical demonstration, a combination characteristic of Rohault as a physicist.

Take for instance, Cyrano's description and explanation of the travelling machine which took him from Southern France to the States and Empires of the Sun. Having had all the materials and mathematics instruments brought to him in prison, he constructs the vessel for his escape. Use of the sun's rays and nature's abhorrence of a vacuum account for the machine's ability to take off from the Earth, travel through the ether and land on one of the lands which swirl round the sun.

> ...car j'avois bien préveu que le vuide qui surviendroit dans l'icosaèdre à cause des rayons unis du soleil par les verres concaves, attireroit, pour le remplir, une furieuse abondance d'air dont ma boiste seroit enlevée; et qu'à mésure que je monterois, l'horrible vent qui s'engouffreroit par le trou ne pourroit s'élever jusq'à la voûte qu'en pénétrant cette machine avec furie, il ne la poussât en haut.[61]

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[61] C. de Bergerac, Histoire Comique des Etats et Empires du Soleil, nouv. édit., Paris, 1858, pp. 249-50.

It seems certain, from Lebret, that Rohault was accepted by Cyrano's group of friends , but it is not equally certain that Rohault taught Cyrano cartesian physics. The appearance of the *Fragment* in the 1662 edition might be explained by any of three hypotheses: that Cyrano wrote a vulgarised version of cartesian philosophy from notes taken at lessons given by Rohault; that Rohault wrote the *Fragment*, knew the publisher and had it printed anonymously; that Rohault, in his *Traité*, plagiarised Cyrano's earlier work. Since we have evidence of Rohault's integrity and intellectual honesty we may safely do away with hypothesis number three, but how do we decide between the other two hypotheses? Similarly, the cartesian inspiration of the *Histoire du Soleil* may be explained by two hypotheses: that Cyrano had read Descartes' works or that Rohault had taught him cartesian philosophy.

Rohault then, in the early sixteen fifties, was one of Cyrano de Bergerac's group of friends. It is a moot point whether or not he taught Cyrano cartesian philosophy. By the mid-sixteen fifties, when Henri Lebret called him "illustre mathematicien qui a tant fait de belles eppreuves physiques" he was on the verge of acceptance by the élite of the Parisian scientific community.

In 1658, he took part in Clerselier's controversy with Pierre Fermat on Descartes' Dioptrics and was described by the former as "un de mes amis...savant mathématicien et des mieux versés que je connoisse en la philosophie de M. Descartes...".[62]

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[62] *Oeuvres de Fermat*, ed. P. Tannery and C. Henry, 4 vols., Paris, 1891-1912, II, Clerselier à Fermat, 15 Mai 1658, 389.

The same year he was a prominent member of the newly-regulated Montmor Academy, held by a number of historians to have been the womb of the Académie des Sciences. In 1659, his own conferences were described by Clerselier as a well-established and flourishing institution.[63]

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[63] Clerselier's preface to Tome II of Descartes' Lettres, Paris, 1659, printed in O.D., V, 630.

CHAPTER II

HIS ARRIVAL

Between 1659 and 1672 Rohault's reputation as a natural philosopher grew enormously. This chapter and the next attempt to give reasons for his acceptance into the Parisian scientific élite and to define the extent of his success. Above all, his progress depended on his own ingenuity, but by emphasising the major influences at work upon him we hope to increase our understanding of his career in the natural sciences.

In an autobiographical passage in his Traité, Rohault declared that what he considered most important for his intellectual development was reading the Ancients and Moderns, conversing with scholars and artisans and basing his reasoning on experiments and mathematical truths.

> "...ayant passé quelques années à lire les Anciens et les Modernes, mais avec une ferme resolution de ne les suivre, qu'autant que je verrois que les uns ou les autres auroient raison, il me semble que je n'avois pas esté entierement frustréde mon attente. Mais pendant que je tâchois ainsi à m'instruire par la lecture des livres, et par la conversation des sçavans, et de ceux qui excellent dans les arts, je ne laissois pas d'exercer toûjours ma raison, meditant en moy-mesme sur divers sujets, et tâchant toûjours de fonder mes raisonnemens sur des veritez de Mathematique et sur des experiences certaines." 1

[1] Rohault, Traité, Paris, 1671, preface, not pag.

We have noted the importance of Rohault's conversations with scholars and artisans and dealt generally with what he does not mention, his education in Amiens and the University of Paris. Some idea of his reading material can be gained from his published and unpublished work and from the inventory, made in 1673, after his death. It is obvious from these sources that he read widely on what is now called physics and mathematics (see Table I, p. 24).

The cartesian inspiration of Rohault's phrase, "tâchant toûjours de fonder mes raisonnemens sur des veritez de Mathematique et sur des experiences certaines", was another important reason for his acceptance into the Parisian scientific community. Succeeding in using Descartes' method, in May 1658 he entered the debate between Fermat, Clerselier and De La Chambre with his "Reflexions ou Projet de Réponse à la lettre de M. de Fermat qui contient ses objections sur la Dioptrique de M. Descartes".[2] He defended Descartes' geometrical approach, divided Fermat's letter into its component parts and proceeded to answer each of Fermat's criticisms in a lucid, 'mathematical' fashion. In his conferences, according to René Fedé,[3] he 'established' his cartesian principles before examining the

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[2] Oeuvres de Fermat, ed. P. Tannery and C. Henry, 4 vols., Paris, 1891-1912, II, 391-6. In answering Fermat's letter to Mersenne of December 1637 (ibid., 116-25), Rohault claimed for Descartes the right to consider the determination of a body in motion as changed, not only when it changes direction but also when its speed is increased or decreased. He was thus instrumental in changing Fermat's criticism of Descartes' Dioptrics. For an excellent discussion of this controversy see A.I. Sabra, Theories of Light, London, 1967, chpts. III and IV.

[3] Bib. S$^{te.}$ Geneviève MSS 2225. Conferences sur la physique faites en 1660-61 par Jacques Rohault...recueilli par M^{r} Fedé advocat.

TABLE I - Rohault's Reading: Authors Mentioned by Name

	Traité de Physique	Physica[4]	Oeuvres Posthumes	1673 Inventory[5]
ANCIENTS	Ptolemy	Aristotle	Euclid	Archimedes
	Epicurus	Democritus	Archimedes	Euclid
	Archimedes	Epicurus		Apollonius
	Aristotle	Plato		Fabry
	Aristarchus	Thales		Riccioli
	Ecphantes	Archimedes		
	Hipparchus	Pliny		
	Seleucus			
	Philolaus			
	Plato			
	Thales			
MODERNS	Descartes	Agricola	Errard	Grévin
	Huygens	Bruno	Marolis	Viète
	Pecquet	Cardan	De Ville	Ubaldi
	Steno	Campanella	Pagan	Bourgovin
	Harvey	Clavius		Aguilonius
	Gayan	Bellini		Duret
	G. Cassini	Bodin		Hérigone
	Galileo	Copernicus		Roberval
	Asselli	Brahe		Pagan
	Copernicus	Kepler		Descartes
	Brahe	Castelli		Regius
		Napier		De Ville
		Briggs		
		Gellibrand		
		Hobbes		
		Galileo		
		Descartes		
		Gassendi		
		Roberval		
		Pecquet		

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[4] B.N. Fonds Français 14837, Physica rerum particularum, seu naturae phaenomenon explicatio, fols. 112-210. Volume 14837, entitled "Divers Traités de Rohault", was deposited in the king's library by the Abbé de Targny early in the eighteenth century. It includes a number of treatises whose authors were Antoine Arnauld, Dom Robert Desgabets, N. Boileau, J. Racine and F. Bernier. The 'Physica' is by a cartesian but I am unable to say for certain that its author was Jacques Rohault.

[5] see Appendix 3.

properties of matter in a hypothetico-deductive manner and supporting his deductions with a surfeit of experimental illustrations. In his Traité, he credited the success of his conferences to the fact that he had followed the advice of friends to propose things simply and in a mathematical order.[6]

For Rohault, the Jesuit college and the University provided a groundwork of 'Ancient' philosophy, the workshops a mechanical dexterity and sense of application. Reading, discussions with scholars and Descartes' method brought him into contact with the leaven spreading of the 'new philosophy', widened and clarified his experience and provided him with a methodological framework within which to work.

What other events account for Rohault's success among Paris savants? Late in 1657 or early in 1658 he became a member of the newly-regulated assembly which met every Tuesday at the house of H.L. Habert de Montmort in the Rue St. Avoye. Montmor's Academy was one of many associations of scholars and erudite amateurs who met at the house of a wealthy patron to discuss and analyze problems in a wide variety of subjects. Earlier in the century, those who were interested in natural philosophy had gathered around Descartes when he visited Paris, at the 'cabinet' of the brothers Dupuy, chez Mersenne, l'abbé Picot, Chantereau Le Febvre and Le Pailleur.

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[6] Rohault, Traité, preface, not pag.

Montmor, himself, had frequented the 'cabinet' of le Président de Thou[7] and the conferences of the Abbé Bourdelot at the Hôtel de Condé,[8] before meetings began at his own house under the tutelage of Pierre Gassendi. Two years after Gassendi's death, Du Prat and Sorbière drew up regulations formalising the meetings at Montmor's. Like many other early scientific organisations Montmor's aimed "...d'entretenir correspondance avec les sçavans de France et des pays estrangers..."[9] and to pursue "...la plus claire cognoissance des oeuvres de Dieu, et l'advancement des commodités de la vie, dans les Arts et les Sciences qui servent à les mieux establir."[10] Like others it included wealthy burgesses, "magistrats" and members of the "noblesse de robe".[11] But it also included members of the élite of the Parisian scholarly community: Pierre Carcavi, Roberval, Samuel Sorbière, Jean Chapelain, Jean Pecquet, Pierre Petit, Christian Huygens, Adrien Auzout and Claude Clerselier. Acceptance by this group placed Rohault in the front rank of the Parisian scientific movement.

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[7] B.N. F.Fr. 13041, J.A. Portner à I. Bulliau, 4 avril 1656, fol.228vo.

[8] Le Gallois, Conversations de l'Academie de M. l'abbé Bourdelot, Paris, 1672, Entretiens servant de préface, p. 56.

[9] [S. Sorbière], Relations, lettres et discours de M. de Sorbière sur diverses matières curieuses, Paris, 1660, Reglemens de l'Assemblée de Physiciens, qui se fit à Paris chez M. de Montmor l'an 1657, p.633.

[10] ibid., p. 632.

[11] O.H., II, 174. In 1658, Chapelain described the members of Montmor's. "L'Assemblée estoit nombreuse et de plus de quarante personnes, entre lesquelles il y avoit deux cordons bleus, le Marquis de Sourdis et Monsieur Du Plessis Guenegaud Secretaire d'Estat, plusieurs Abbés de conditions, plusieurs Maîtres des Requestes, de Conseillers au Parlement des officiers de la Chambre des Comptes, des Docteurs de Sorbonne, plusieurs Gentilzhommes qualifiés, des Medecins de reputation, force Mathematiciens d'importance et quantité de Sçavans lettres...".

It was in this environment that Rohault's friendship with Claude Clerselier flourished and grew. The basis of their friendship was their love of Descartes and an eagerness to promote Descartes' philosophy. The two men were the standard-bearers of cartesianism at Montmort's where they were assured of a sympathetic hearing from at least Montmort himself.[12] Rohault was noted for his experiments on 'vacua'.[13] And Clerselier read to the Assembly a letter which he wrote in Descartes' name, answering Roberval's objections "touchant le mouvement dans le plein."[14]

Clerselier and Rohault were brought even closer together in September 1664 when Rohault married Clerselier's daughter, Geneviève.[15] According to Baillet, whose view seems substantially correct, Clerselier successfully overrode the opposition of his family to the marriage because of his zealous devotion to cartesian philosophy.

> "Tous les parens de la Demoiselle, hors son père, eurent beaucoup de déplaisir de cette mes-alliance; et le nouveau gendre même s'étant rangé de leur party avoit tâché de s'en excuser. Mais rien ne pût vaincre M. Clerselier, qui trouvant sa fille toute disposée a luy obéir, et tres contente de ce party, voulut absolument ce marriage pour la considération seule de la philosophie de M. Descartes, dont il prévoyoit que son gendre devoit être un puissant appuy."[16]

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[12] "Liste de Quelques Gens de Lettres Français vivans en 1662 par M. Chapelain", in Continuations des Mémoires de Littérature et d'Histoire de M^r de Salengre, 11 vols., Paris, 1726-49, I, 53. "En matière de Philosophie, il [Montmort] fait profession de Décartiste; et le bruit est, qu'il n'a érigé une assemblée académique que chez lui, que pour établir cette nouveauté...". See also, Lettres de Jean Chapelain, ed.P.H. Tamizey de Larroque, II, 406, 530, 622, 640.

[13] see below, Chapter III, p. 47.

[14] O.D., V, 648. See also Lettres de M. Descartes, 3 vols., Paris, 1657-67, III, 538. Clerselier read the letter to the assembly, 13 July 1658.

[15] A.N. Minutier Central, 39:110, Contrat de Mariage, 8 Sept. 1664.

Because of the friendship with Clerselier, Rohault's financial and social position was secured. Geneviève's dowry of twelve thousand livres and Clerselier's patronage ensured his rise up the social ladder. He was kept in close contact with the most recent cartesian scholarship and given the opportunity of studying Descartes'papers which had come to Clerselier from Pierre Chanut.[17]

Rohault's public conferences on cartesian physics enjoyed considerable success among Paris savants. Huygens, Oldenburg and Clerselier gave glowing accounts of the conferences that they attended.

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[16] Baillet, Vie de Descartes, Pt. II, Livre VII, ch.iii, p. 241. The signatories to the marriage contract of 8 Sept. 1664 include, on Rohault's behalf, Jacques Rohault, Marchand Bourgeois de Paris, Jacques Boulot, Marchand Bourgeois de Paris, Jean Le Cuntrix(?), Marchand Drapier, Bourgeois de Paris, and on Clerselier's behalf, Catherine Clerselier, wife of Adrien Chanut, Seigneur de la Haye, Martial Chanut, Conseiller et Ausmonier ordinaire de la Royaume et du Roy, Abbé...d'Issoire en Auvergne, Hector Chanut, Conseiller du Roi en son Grand Conseil, Philippe Hurel, Sieur de Neauville, Commissaire des gardes. Itemised in the 'Titres et Papiers' of Claude Clerselier's inventory (cotte 20) is an Arrest du Conseil d'Estat of 9 Juillet 1668 "par lequel sa Majesté a maintenu et gardé" the Clerselier family "...honoraire en la possession de prendre la qualité de noble et d'Escuyer...". (A.N. Minutier Central, 39:159, L'Inventaire de Claude Clerselier, 10 Jan. 1685).

[17] O.D., V, 616, Dedication to Pierre Chanut of the second edition (1663) of Tome I of Descartes' Lettres. Chanut died in 1662. On the history of Descartes' papers see C. Adam, "Clerselier éditeur des Lettres de Descartes", Comptes Rendus des Séances et Travaux de l'Académie des sciences morales et politiques, CXLV, 1896, pp. 722-54.

Henry Oldenburg wrote to his friend Saporta:

> "At Mr Rohault's vision has lately been under consideration; so many fine things were uttered that a whole treatise, not a letter, would be needed to relate them...all...was handled so precisely and clearly that there was no room for doubt."[18]

Christian Huygens, during his visit to Paris between October 1660 and March 1661, reported to his brother Lodewijk:

> "J'ay aussi esté quelquefois chez M. Rohaut qui explique la philosophie de M. Descartes, et fait des belles experiences, et la dessus des beaux raisonnements."[19]

Clerselier, with the exaggeration of the interested propagandist, described how Paris was full of a large number of persons interested in the new philosophy who had gone to Rohault's and "...ont enfin esté contraints de donner les mains, et d'ennemis ouverts qu'ils essoient de cette doctrine [Descartes'], de s'en declarer les sectateurs et les deffenseurs."[20]

Rohault's conference technique, according to Clerselier,[21] was to give a talk on problems in physics for about an hour, establishing his principles and proving them by demonstrated experiments. With an admirable moderation and patience he permitted interruptions to his discourse, answered any objections, took up the

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[18]The Correspondence of Henry Oldenburg, ed. and trans. A.R. Hall and M.B. Hall, 5 vols., Madison and Milwaukee and London, 1965-8, Oldenburg to Saporta, 18 June 1659/28 June N.S., I, 263.

[19]O.H., Christian Huygens à Lodewijk Huygens, 18 Dec. 1660, III, 210.

[20]Clerselier's preface to Tome II of Descartes' Lettres, O.D., V, 630.

[21]Rohault, Oeuvres Posthumes, preface, not pag.

argument again and completed what he had set out to do. The debate was then thrown open to the floor and was usually terminated by his answer to, and resumée of, all that had been said.

The most remarkable of Rohault's experiments, continued Clerselier, were, those on 'the weight of air', particularly one performed with an instrument of his own invention "semblable à peu prés à la figure dont les Anatomistes se servent pour representer la grande Artere ascendante et descendante",[22] those on light, especially the demonstration of Descartes' explanation of the rainbow by means of an artificially created rainbow projected on to a screen, and finally, those on the properties of the magnet, for which he had a special box of materials "d'où il tiroit chaque piece l'une aprés l'autre, selon l'effet où la proprieté qu'il vouloit prouver, et l'experience que pour cela il avoit à faire."[23]

The success of Rohault's conferences was mainly due to his ingenuity. Clerselier's praise for his demonstrative and mechanical competence, his clear and precise manner of explanation and his prowess in debate is confirmed by other contemporary sources. His experiments were renowned in Parisian intellectual society , from Montmort's Academy to the salon of Madame du Sablé. Florin Périer, executor of the famous Puy-de-Dôme experiment, praised him for his "...adresse merveilleuse pour trouver des experiences et pour les expliquer."[24] His clarity and economy of expression are apparent

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[22]loc. cit.

[23]loc. cit.

[24]B. Pascal, Traité de l'Equilibre des Liqueurs, 2e édit., Paris, 1664, preface, not pag.

in his Traité de Physique and Fedé's account of his conferences. His prowess in debate was underlined by Malebranche, who wrote of him:

> "...tout le monde sçait assez avec quelle justice et quelle force ce sçavant homme repoussoit les coups qu'on lui vouloit porter et qu'avec deux ou trois paroles prononcées sans chaleur et sans mouvement, il abattoit l'imagination de ceux qui tout pleins d'eux-mêmes croyoient le couvrir de confusion."[25]

The 'cabinets', conferences and academies which flourished in Paris in the 1660s, centres of education, seed-beds of feminine revolt, acceptable forms of entertainment and vehicles for the dissemination of scientific ideas, were at the one extreme foppish and dilettante, and at the other seriously devoted to painstaking research into natural phenomena. The conference milieu and the 'scientific community' were not necessarily synonymous but it was in this milieu that members of the 'community' moved.

Apart from his own conferences and Montmort's to 1664, Rohault played an active role in at least two others; those of Pierre Michon, the Abbé Bourdelot, and M. de Launay. "Le sieur le Gallois" included in his list of the "Athlètes d'Esprit" at Bourdelot's "...Gallois, Auzoult, Pequet, Borelli, Mariotte, Roberval...Justel, de Laulnay, Rohault, Condemoy...".[26] In 1672, Clerselier, in a letter to Dom Robert Desgabets, gave an account of a month-old dispute between the cartesian Rohault and gassendist De Launay which had taken place

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[25] Oeuvres de Malebranche, pub. sous la direction d'André Robinet, 20 vols., Paris, 1958-62, Préface contre Le Livre de Foucher, II,497.

[26] Le Gallois, Conversations, préface, p. 58.

at De Launay's house:

> "...pour cela il s'est tenu trois ou quatre fois des conferences publiques chez ledit S[r] de Launay aux faubourg St. Germain ou entr'autres fois M[r] le Duc de Liancourt, le Pere Desmarets, le Pere Pardies et quelques autres Jesuites s'y sont trouvez et la le vuide, la divisibilité de la matiere a l'infini et les atomes ont esté fort aggitez...".27

From his Traité too, it is evident that Rohault circulated freely among Paris savants keeping up to date on the most recent developments in the scientific world.[28]

Rohault consolidated his reputation among Parisian savants during the last years of his life with the publication of his Traité de Physique in 1671. The fame achieved by the Traité was principally posthumous but the work was well received while its author was still alive. Clerselier wrote to Desgabets, "Le Livre de M[r] Rohault est icy en estime. Il se debite assez passablement bien pour un livre de science et de prix...".[29] R.P. René Le Bossu, in a treatise read at Bourdelot's academy, entitled "le Parallèle de la Physique d'Aristote et de celle de Mons. Des Cartes",[30] admired Rohault's work as an ordered synthesis of Descartes' physics.

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[27]Bibliothèque Municipale de Chartres, Mss. 366, Clerselier à Dom Robert Desgabets ou il rend compte de ce qui se dit à Paris à l'occasion des disputes sur le S[t.] Sacrement (?). Unfortunately, volume 366 was severely damaged when the library buildings were destroyed by fire in 1944.

[28]see below, Chapter IV and Chapter VI.

[29]Chartres, 366, loc. cit.

[30]Appended to Le Gallois, Conversations, Paris, 1672. Rohault's name was printed in full in the text of R. Le Bossu, Parallèle des principes de la physique d'Aristote et de celle de R. Des Cartes, Paris, 1674.

The Journal des Sçavants praised it for amassing "quantité de choses dont la connoissance est également utile et curieuse."[31]

Rohault's reputation was not confined to what we have called the Parisian scientific élite but grew among a wide variety of other groups. His name was linked with artisans, merchants, 'gens du monde', the nobility, university teachers, literary figures and theologians.

Rohault's mathematics lessons were designed to meet the demand of "les jeunes qui s'appliquent aux mathématiques, la jeune noblesse qui s'attache aux armes, et ceux qui s'adonnent au négoce et aux affaires."[32] Clerselier tells us that Rohault was especially successful with high society. The "plus qualifiez du Royaume, soit de la robbe, soit de l'épée, soit de la Cour",[33] could certify like him that Rohault's teaching was beyond comparison. "Les plus grands" vied with one another to have him as teacher of their children.[34] He taught the young Messieurs les Princes de Conty "dès leur bas âge"[35] and there were even plans to have him teach philosophy and mathematics to Monseigneur le Dauphin.

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[31] Journal des Sçavans, 22 Juin 1672.

[32] ibid., 13 Dec. 1683.

[33] Rohault, Oeuvres Posthumes, preface, not pag.

[34] loc. cit.

[35] François-Louis de Bourbon, prince de Conti, was born 4 April 1661. Louis Armand was born 30 April 1664.

The only independent verification for this lavish praise of Clerselier is in the Accounts of the House of Conti. In the Accounts of Madame of 1668 and 1669 there are three references to Rohault. In 1669, he received 264 livres for four months of maths lessons,[36] in 1668 150 livres for two globes and 319 livres "pour avoir montré diverses choses a mond. seigneur pend. quatre mois ou pour des escris avec des figures qu'il a fournis."[37]

Clerselier further alleged that "des personnes de tout âge de tout sexe et de toute profession"[38] came from Paris, from the provinces and from abroad to hear Rohault's conferences. In the preface to the second volume of Descartes' Lettres he tells of the approval given to the conferences by the Parisian social élite. He mentions

> "Le grand nombre de personnes de condition qui se trouvent en cette Assemblée (ou les Dames mesme tiennent souvent le premier rang) et qui n'en sortent jamais qu'avec applaudissement et admiration...".39

The 'personnes de condition' included the Duc de Guise to whom Rohault dedicated his Traité de Physique[40] and D'Olivier d'Ormesson,

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36 A.N. R* 276, Compte de Madame 1669, Chambre et garderobe, fol.23vo.

37 A.N. R* 274, Compte de Madame 1668, Items 26 and 27, fol. 25ro and vo.

38 Rohault, Oeuvres Posthumes, preface, not pag.

39 O.D., V, 630-1.

40 Rohault expressed his gratitude to De Guise for "...l'attention qu'elle a daigné prêter à l'explication que je luy ay faite de la plus-part des choses qui sont comprises dans ce Traité...". Clerselier, in his dedication of Rohault's Oeuvres Posthumes to Monseigneur d'Estrées, mentions that "...les Marquis de Coeuvres et de Temines, avec les plus grands de la Cour, n'ont pas autrefois dedaigné d'avoir pour maistre [Jacques Rohault]".

whose Journal recorded a visit to Rohault's in 1664 to see experiments on the magnet.[41] 'Les Dames' referred to Madame du Sablé, at whose salon the Marquis de Sourdis gave an account of Rohault's experiments on capillarity,[42] and to the enthusiastic devotees of cartesian philosophy, Madame de Bonnevaux and Madame de Guederville whom Huygens met at Rohault's in December 1660.[43]

Rohault was the friend of at least two great literary figures of the age, Cyrano de Bergerac and Jean-Baptiste Poquelin. Grimarest, in his Vie de Molière, described Rohault as consoling a Molière fraught with worries about his marriage, a model for the philosopher in Le Bourgeois Gentilhomme and as the satisfied examiner of Molière's translation of Lucretius.[44] The truth of these anecdotes is unknown but the friendship of the two men is certain. In 1668, Rohault acted as an intermediary for a loan of 10,000 livres which Molière made to his father for repairs to "La Maison de l'Image Saint-Christophe".[45]

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[41] D'O.L. D'Ormesson, Journal, ed. M. Chéruel, 2 vols., Paris, 1861, II, 146.

[42] B.N. F.Fr. 17050, Portefeuilles Vaillant, fol. 20.

[43] O.H., XXII, 541. Marie Thiersault was the wife of Sébastien Dubois, sieur de Guederville. Marguerite Buffet, in her Nouvelles Observations sur la Langue Française ... avec les Eloges des Illustres Sçavantes, Paris, 1668, says of Mme. de Bonnevaux, "Jamais la Philosophie de M. Descartes n'a receu plus d'honneur et n'a été plus estimé que depuis l'approbation en cette illustre Dame...", p. 265.

[44] Jean-Léonor Le Gallois, sieur de Grimarest, Vie de Molière, ed. G. Mongrédien, C.N.R.S., 1955, pp. 80-3, p.111, pp. 127-8.

[45] A.N. Minutier Central, 113:66, Constitution et Déclaration, 31 Août 1668. The texts are printed in M. Jurgens and E. Maxfield-Miller, Cents Ans de Recherches sur Molière, Paris, 1963, pp. 431-5.

There is evidence for Rohault's association with university men and theologians. Clerselier wrote, "...plusieurs qui portoient le bonnet; and qui professoient publiquement dans les Colleges, n'ont point eu honte de devenir ses disciples."[46] Doctor Nicolas Liènard of the Paris medical faculty, friend and disciple of Rohault, wrote the epitaph for Rohault's 'heart'[47] which was placed beside the remains of Descartes at S^te^ Geneviève du Mont in 1695.[48] Rohault's Lettre à Guyard[49] and its exegesis, Entretiens sur la philosophie,[50] attempted to allay the fears of members of the Paris Theological Faculty who felt that the 'new philosophy' undermined the teaching of Aristotle and threatened the dogma of the eucharist. The Lettre was openly addressed to Nicolas Guyard,[51] sindic of the Sorbonne (second in importance to the Rector in matters of moral discipline in the University), and gave an account of Rohault's dialogue with Guillaume Lestoc,[52] a doctor in theology at the same institution.

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[46] Rohault, Oeuvres Posthumes, preface, not pag.

[47] Quos unum doctrina facit, compingit in unum
Docta que Cartesii ossa hoc Marmor, Corque Rohaldi.

[48] Journal des Sçavans, 9 Mai 1695 and Bib. S[te] Geneviève, Mss 687, fol. 1.

[49] B.N. F.Fr. 14837, fols. 211-24(copy): B.N.F.Fr. 17155, fols.292-7(original).

[50] J. Rohault, Entretiens sur la philosophie, Paris, 1671.

[51] See A.N. M 253, Conclusions de la Faculté de Théologie 1661-85, March 1671, fol. 141[ro].

[52] ibid., February 1671, fol. 139[ro]. Guyard and Lestoc were not fictional characters.

Clerselier's campaign to gain acceptance of Descartes' interpretation of the eucharist brought Rohault into contact with Dom Robert Desgabets,[53] Dom Henri Hennezon[54] and R. Père Nicolas Poisson.[55] Poisson and Rohault exchanged gifts and corresponded with one another on matters in physics, mechanics and the "brouilleries qui sont presentement en la philosophie."[56]

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[53] Dom Robert Desgabets (c.1620-1678), Benedictine Prior of St.-Arnoult and later of Breuil, near Commercy, noted for his interest in blood-transfusion, mechanics and Descartes' interpretation of the eucharist. See P. Lemaire, Le Cartésianisme chez les Bénédictins, Thèse, Paris, 1901.

[54] Dom Henri Hennezon, Benedictine Prior of St. Michiel and close friend of Cardinal du Retz. See Chartres, 366, Desgabets à Clerselier, Juillet 1671. Desgabets recalls having taken Hennezon to Clerselier's "...et de luy avoir fait voir les experiences du vuide et de l'aymant chez M. Rohault."

[55] R.P. N.J. Poisson (1637-1710), Superior of the Oratorian college at Vendôme, commentator on Descartes' 'method', 'mechanics' and 'music'.

[56] Bibliothèque Victor Cousin, Mss vol. 4, J. Rohault à N.J. Poisson, 5 Août 1671, fol. 42. See also, ibid., J. Rohault à N.J. Poisson, 16 May 1671, fol. 41, and Archives Municipales d'Honfleur Fonds Adry (15 11) 4, J. Rohault à N.J. Poisson(?), 9 juillet 1671, fols.34-5. Poisson sent Rohault a copy of his commentary on Descartes' Method and "Les Parmes de Vendosme". Rohault sent Poisson 18 glass drops "pour faire diverses experiences".

Poisson, in his commentary on Descartes' method, said that he corresponded with a large number of cartesians in France and abroad. In 1899, Abbé A. Clement referred to the 'great number of letters' which Poisson wrote to Rohault, Clerselier and Desgabets, and cited A.N. M 220, Liasse B, p. 687 et seq. Unfortunately, A.N. M 220 contains a Ms copy of Batterel's Mémoires Domestiques pour servir à l'histoire de l'Oratoire.

Despite an extensive search, including correspondence with the Archivist of the Maison de l'Oratoire at Montsoult, the above three letters are all that I have found of Rohault's correspondence with Poisson.

There were, however, limits to Rohault's success. His celebrity made him a candidate for the Académie des Sciences or at least, for a financial award from the government. Yet neither of these honours was conferred on him; probably because of the sectarian nature of his adherence to the work of Descartes. In 1663, the first year of a series of financial rewards to men of letters, Descartes' works were put on the Index. It would have been tactless of Louis XIV or Colbert to have given encouragement to disciples of someone whose works had been recently condemned by the Holy See. Furthermore, cartesian doctrines and cartesian propagandists were frowned upon by Jean Chapelain, a member of the recently founded Académie des Inscriptions et Belles Lettres and advisor to Colbert on the distribution of royal grants.[57]

The suggestion that Rohault might have been made a member of the Académie des Sciences is not as remote as it first appears. He had played an eminent role at Montmor's academy and may have belonged to Thevenot's assembly, two groups which actively publicized the need for an Académie des Sciences. It is by no means certain, however, that he attended the meetings at Thevenot's, whereas there is evidence to suggest that he became estranged from influential members of the scholarly community. Adrien Auzout, a prominent member of Thevenot's group and of the Royal Academy, was an avowed enemy of

[57] see B.N. Collection Baluze 362, fols. 42-58.

[58] O.H., Christian Huygens à Lodewijk Huygens, 18 Jan. 1662, "Adrien Auzout...le [Rohault] haissoit mortellement et le faisoit enrager", IV, 11.

Rohault's, an enemy strong enough to exclude him from both assemblies if he so desired.[58] As early as January 1662 Huygens complained to his brother Lodewijk of Rohault's pedantry[59] and in 1664 Rohault returned the compliment when he refused Huygens his explanation of 'why mercury did not descend in very thin glass tubes'.[60]

Colbert's advisors on the choice of members for the Académie des Sciences, according to Perrault, were "M. Chapelain, M. l'abbé de Bourseis et M. de Carcavi".[61] It is difficult to know precisely what influence these men had. Chapelain's letters tell us that he failed to procure a position for the Danish anatomist, Steno, because Steno had not remained in Paris.[62] At least there was opportunity for the reiteration of Chapelain's reasons for excluding cartesians from the pension lists.

Most of the original members of the Académie were either trained technicians, important in the sense that they held offices connected with the sciences, or were favoured by members of the 'petite académie',[63] categories to which Rohault did not belong.

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[59] loc. cit. "Il y a toujours un peu de pedanterie dans son fait...".

[60] O.H., Christian Huygens à Robert Moray, 20 Fév.1664, V, 29.

[61] C. Perrault, Mémoires de ma vie, ed. P. Bonnefon, Paris, 1909, p. 43.

[62] Lettres de Jean Chapelain, ed. T. de Larroque, Chapelain à Steno, 31 Mars 1667, II, 507.

[63] Bourdelin was Apothicaire du Duc d'Orléans, Gayant, Chirurgien de Paris et des Armées du Roi. Buot was Ingénieur Géographe du Roi and Professeur de mathématiques des Pages de la Grande Ecurie. Marchant was Directeur de la culture des Plantes au Jardin du Roi and Roberval held the chair of Mathematics in the Collège de France. Carcavi and Chapelain had attended Montmor's and Thevenot's and had first-hand experience of the competence of Huygens, Auzout and Frénicle de Bessy.

It must be recognised too, that there were only a limited number of places and that not everyone could be satisfied. In the end, however, Rohault's rigid adherence to Descartes' system was probably the most important reason for his exclusion from an assembly which desired to ban philosophical systems on the grounds that they excluded a free and useful search for truth in all its aspects.

CHAPTER III

CARTESIAN PROPAGANDIST

During his lifetime Rohault was subject to as well as master of the fortunes of Descartes. His success was limited by his sectarianism and by the influence which Claude Clerselier exerted on French cartesians. Descartes' physics was not accepted by the majority of natural philosophers in Paris whose ideals were objectivity, particular discoveries, the compilation of empirical data, rather than adherence to any 'system'. Among natural philosophers cartesians formed a small but evangelically vigorous school and in this school, Rohault was undoubtedly the ablest exponent of cartesian physics. But the leader of the school, its spiritual father, was Clerselier rather than Rohault. Rohault's greatest achievement and influence on a large audience came after his death, with the success of his Traité de Physique.

Some historians of cartesianism have seen 'le grand siècle' as Descartes' century. They traced the spread of Descartes' work throughout France, the various layers of French society, the realms of science, philosophy, theology, literature and the arts and even the government of Louis XIV. Naturally, they found what they were looking for but failed to weigh Descartes' influence in the balance with that of the gassendists, 'pascalins', aristotelians, alchemists and Jansenists. Furthermore, Descartes had treated a wide variety of subjects. His thought had developed over a period of time.

Parts of his work were ambiguous. There were critics who publicized their dissent. These complications influenced his followers to choose, reinterpret and develop the aspects of his work which interested them most; Desgabets and Clerselier were attracted by Descartes' interpretation of the Eucharist, Cordemoy[1] developed a theory of ideas which laid the foundations of occasionalism, La Forge[2] interested himself in the problems of physiology and Rohault dressed his physics in the cloth of empiricism. The historian who wishes to measure precisely the extent of Descartes' influence and the directions which it took after his death is thus faced with a formidable task. Aware of this fact we shall attempt to gauge the reception given to Descartes' works by French natural philosophers and Rohault's contribution as a cartesian propagandist particularly between 1658 and 1672.

The claims of René Fedé and Claude Clerselier that "il n'y a pas un homme d'esprit qui ne suive la philosophie de M. Descartes"[3]

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[1]Géraud de Cordemoy, lawyer, historian and philosopher, member of Montmor's academy, developed his theories in Le Discernement du corps et de l'âme, Paris, 1666, and Discours physique de la parole, Paris, 1668.

[2]Louis de la Forge (1632-66), medical doctor of Saumur, also described an embryonic form of occasionalism in his remarks to L'Homme de René Descartes..., Paris, 1664, and the Traitté de l'Esprit de l'Homme, Paris, 1665. On La Forge, see, G. Cerclais, "Un disciple saumurois de Descartes. M. de la Forge", Société des Lettres du Saumurois, CVI, Fév. 1957, pp. 21-9. On La Forge and Cordemoy, see, J. Prost, Essai sur l'atomisme et l'occasionalisme dans la philosophie cartésienne, Paris, 1907.

[3]Les Méditations Métaphysiques de René Descartes...par R.F.[René Fedé], 3e édit., Paris, 1673, Au Lecteur, not pag.

and that several savants and academies had forsaken the "...anciens Instaurateurs des Sciences, pour se ranger du party de nostre nouveau mais incomparable Philosophe",[4] are loyal exaggerations in favour of their master but of small value in describing Descartes' reception among men whose principal interest was natural philosophy.

Certainly, savants like Roberval, Fermat, Huygens, Newton and Leibniz were stimulated and provoked by Descartes' work and may be described as having been touched by the spirit of cartesianism. But those who wholeheartedly subscribed to Descartes' method, principles and 'system' were few in number. [This stringent definition of 'cartesian' excludes those like Huygens[5] who otherwise might be described as followers of Descartes.] This is apparent in an analysis of Parisian conferences, the Académie des Sciences, and the Journal des Sçavants during the period before Rohault's death in 1672.

The editors[6] of the Journal des Sçavants aimed to provide their readers with "catalogues and reviews of the most important books published throughout Europe, eulogies of famous men, the principal decisions of secular and ecclesiastical tribunals and the universities of Europe, to make known 'les nouvelles découvertes qui se font dans les Arts et dans les Sciences', in short, to give an account of everything worthy of the curiosity of 'des Gens de Lettres' ".[7] The Journals' regular readers thus kept abreast of

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[4] Clerselier's preface to Tome II of Descartes' Lettres in O.D., V,630. See also Chartres, 366, Clerselier à Berthet, 11 nov. 1659. Clerselier says of Descartes' philosophy, "Il y a des universitez toutes entieres qui ont renoncé a tout ce qu'on leur avoit appris jusques icy de physique pour embrasser et enseigner publiq^{mt} ses opinions".

[5] Huygens' position was much more flexible than that of a zealous cartesian. He rejected Descartes' principles, 'a priori' deduction and answers to most scientific problems. But he was excited and much inspired by Descartes' work.

[6] Denys de Sallo (1665) and Jean Le Gallois (1666-72).

developments in a wide variety of subjects: theology, literature, history, belles-lettres and most important of all, technology and the natural sciences.

Accounts of the observations of stars, comets, eclipses and planets made by Auzout, Cassini, Campani, Bulliaud, Riccioli, Hook, Hevelius, Petit, Grandamy[8] and of the controversies which they aroused,[9] occurred regularly in the Journal as did descriptions of the astronomical instruments of Divini, Campani, Auzout, Picard and Newton.[10] On the 28th June 1667, for example, the Journal reported Auzout and Picard's observations demonstrating the use of the micrometer as a "Manière exacte pour prendre les diamètres des Planetes, la distance entre les petites étoiles etc.". The anatomical experiments and discoveries of the English Royal Society and the Académie des Sciences, reviews of editions of Hippocrates and Avicenna, the works of Bartholin, Steno, de Graef, Willis, Warthon, Malpighi, Kerckring[11] and a prolonged debate on blood transfusion captured the attention of those interested in medicine. The issue of 6 February 1668

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[7] Journal des Sçavans, 5 Jan. 1665, Address to the Reader.

[8] See, for example, the Journals of 22 Fév. 1666, "Extrait d'une Lettre escrite de Rome, touchant les nouvelles découvertes faites dans Jupiter par M. Cassini...", 22 Mars 1666,"Dissertation sur la nature des Comètes par M. Petit", 7 Juin 1666, "Deux eclipses en l'espace de quinze jours dechiffrées par le P. Grandamy S.J.".

[9] ibid., 18 Jan. 1666, "Responses de Monsieur Hook aux considerations de M. Auzout, et quelques autres lettres escrites sur le sujet des grandes Lunettes", 29 Mars 1666, "Extrait du Journal d'Angleterre: Sentiment des Astronomes d'Angleterre sur la contestation arrivée entre deux sçavant hommes (Auzout and Hevelius) touchant une observation faite de la premiere des deux dernieres cometes".

[10] ibid., 29 Fév.1672, "Nouvelle Lunette Catoptrique, inventée par M. Newton, Professeur des Mathematiques dans l'université de Cambridge".

was dedicated to letters and an extract from the Philosophical Transactions weighing the pros and cons of blood transfusion.[12] Artisans could read about proposals for boat-building and navigation (the use of pendulums in finding longitudes at sea, depth sounding, Fournier's theory and practice of navigation), the spirit-level, Francini's hydraulic machine, Huygen's barometer and Nathan Hodges' report on his observations of the London Plague praising the use of chemical remedies.[13]

This day-to-day, particularist, non-sectarian exposition of developments in the arts and sciences reflected the prevailing mood of the learned world. Descartes and his followers would not seem to have had widespread and totally committed support. In fact, the small

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[11] ibid., 23 Mars 1665, "Nicolai Stenonis De Musculis et Glandulis observationum specimen"; 19 Avril 1666, "Johan Fernelii Pathologiae Liber quartus de febribus, cum earum prognosi et curatione adiecta à Rutgero Loenio Doct. Med. Amstelodami".

[12] The interest of European scholars in blood transfusion is reflected in the Journals of 1667 and 1668. An idea of the controversy may be gleaned from the contents of the issue of 6 Fév. 1668. For example, "Lettre de G. Lamy à M. Moreau Dr. en Medecin de la Faculté de Paris, contre les pretendües utilitez de la Transfusion", "Lettre de C. Gadroys à M. l'Abbé Bourdelot Doc. en Med. de la Faculté de Paris pour servir de Reponse à la lettre écrite par M. Lamy contre la Transfusion", "Lettre de J. Denis...touchant une Folie inveterée qui a été guerie par la Transfusion du sang". The reviewer of this last letter wrote "C'est de l'experience plustost que du raisonnement que l'on doit attendre la decision de la pluspart des questions de Physique...".

[13] Journal, 27 Juin 1672, "...Sive Pestis Nuperae Londini...Nathan Hodges", 15 Nov. 1666, "Machine nouvelle (spirit-level) pour la conduite des Eaux, pour les Bâtimens, pour la navigation et pour la pluspart des autres Arts", 10 Dec. 1668, "Nouvelle Machine hydraulique...M. Francini", 16 Dec. 1669, "Construction d'une machine hydraulique inventée par M. Francini".

number of favourable references to Descartes in the Journal's pages, between 1665 and 1672, originated with Clerselier's cartesian school: reviews of L'Homme, the third volume of Descartes' Lettres, the work of La Forge, Cordemoy, Poisson and Rohault.[14]

The Académie des Sciences, which harboured the élite of the French scientific community, exhibited a similar desire to embark on a detailed compilation of data in their study of nature and the arts and not to adhere to any one 'system'. References to Descartes, of course, can be found in the Academy's minute-books. Bourdelin described the experimenters who removed a dog's brain waiting to see "si cela luy causeroit de grandes douleurs extraordinaires".[15] And in the debate on 'les causes de la pesanteur' in 1669, Huygens and Buot gave explanations which were cartesian in inspiration.[16] But these isolated cases are by no means sufficient evidence to warrant the claim that Descartes' teachings were accepted by the Academy.

In the more easy-going and dilettante atmosphere of private and public conferences, cartesianism made a stronger appeal.

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[14] ibid., 5 Jan. 1665, review of L'Homme de René Descartes, 3 May 1666, review of La Forge's Traité de l'Esprit de l'Homme, 31 Jan. 1667, review of Tome III of Descartes' Lettres. See also the Journals of 26 Nov. 1668 (Poisson), 17 Dec. 1668 (Cordemoy) and 22 Juin 1671 (Rohault).

[15] B.N. F. Fr. Nouvelles Acquisitions, 5133, fol. 5 (at the back).

[16] Archives de l'Académie des Sciences, Registres, V, Registre de Mathématiques (3 Avril 1669-18 Dec. 1669), fols. 151-9 (Buot), fols. 164-180, 191-4 (Huygens).

Rohault, Clerselier, Fedé, Cordemoy and others of the clique vociferously upheld cartesian doctrines especially at the conferences of Habert de Montmort in the Rue St. Avoye, the Abbé Bourdelot in the Rue de Tournon[17] and at Rohault's in the Rue Quincampoix. Rohault, for example, was a regular participant at Montmort's academy.

7th December 1660	"a l'assemblee chez Montmor...Rohault lut les experiences de l'eau qui monte dans les petits tuyaux."
14th December 1660	"Rohault expliquoit des petits tuyaux."
28th December 1660	"chez Montmor, dispute de Rohault et Auzout."[18]

But despite the vigour of Descartes' disciples their voice was only one among many. Sorbière complained of Montmor's that "Chacun veut faire regner ceans sa secte, ses principes ou son hypothese."[19] The sceptics, he said, enjoyed listening to the "...symphonie composée

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[17] C. Le Maire, Paris Ancien et Nouveau, Paris, 1685, pp. 442-3, and Le Gallois, Conversations, preface, pp. 54-77. Fedé is described as someone "...qui possede tellement le Systheme de M. Descartes (dont il est defensor acerrimus) qu'il pourroit le redonner tout entier, s'il estoit perdu" (p. 71), Claude Gadrois as "excellent genie tres sçavant dans les Mathematiques et dans la philosophie, particulierement dans celle de M. Descartes, qu'il professe et qu'il soûtient avec beaucoup de succez." (p. 72).

[18] O.H., XXII, 539-41.

[19] B.N. Cinq Cents de Colbert 485, fols. 441-5, S. Sorbière, Discours prononce le 3 d'Avril 1663. A l'ouverture de l'Academie des des Physiciens, qui s'assemblent tous les Mardis chez Monsieur de Montmort. Reprinted with a few minor changes in G. Bigourdan, "Les Premieres réunions savantes de Paris au 17^{e} siècle", Comptes Rendus des Séances de l'Académie des Sciences, CLXIV, 1917, pp.159-62 and pp. 216-8, p. 216.

d'un Peripateticien, d'un Lulliste, d'un Cartesien, d'un Chymiste, d'un Platonicien, d'un amy de Lucrece, et de quelques autres Philosophes...".[20]

Sorbière's statements were echoed in other 'scientific' conferences. Rohault was a successful exponent of Descartes' physics, de Launay championed Gassendi, Pascal undoubtedly acquitted himself well at Le Pailleur's, others proclaimed a particularist, almost Baconian approach, at Thevenot's and Montmor's, and most of the conference leaders presented themselves as disinterested students of nature. The regulations of Montmor's academy allowed members to follow their own inclination.[21] Le Gallois recommended Bourdelot's conferences because "on n'y epouse aucun parti: on n'y embrasse aucune secte: Aristote n'y pas moins favorablement escouté que Descartes, et Gassendi: on n'y rejette point Raymond Lulle, ny Paracelse, ny Hobbes...".[22] Jean-Baptiste Denis explained the procedure of his conferences, "...j'explique l'état de la Question, et sans m'attacher à aucun party j'appuye mon sentiment sur les Principes qui me paroissent les plus vraysemblables".[23] The conclusion is that, in the better

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[20] loc. cit.

[21] ibid., p. 160. See also, Lettres et Discours de M. de Sorbière, Paris, 1660, pp. 631-4.

[22] Le Gallois, Conversations, preface, p. 62.

[23] J.B. Denis, Recueil des Mémoires et Conferences qui ont esté presentées a Monseigneur le Dauphin Pendant l'année 1672[and 1673 and 1674], Paris, 1672, Avertissement sur les Conferences publiques, qui se sont tous les Samedis chez l'Auteur de ces Memoires...,p. 156.

known conferences concerned with the study of natural philosophy, the defenders of the cartesian faith formed only a small school.

Rohault was at the heart of this cartesian school, its spokesman on Descartes' physics. We can point to his conferences, his role in the fête of 1667 celebrating Descartes' reburial at S^te^ Geneviève, his Traité de Physique and his Entretiens sur la Philosophie to show that his personal contribution to the spread of cartesianism was an important one. In 1667, for example, Rohault asked Simon Foucher to prepare a funeral oration for Descartes. Eight days after the celebration, Rohault, Clerselier and D'Alibert dined with François Blanchart, Superior General of the Genofevins, and on that occasion Rohault performed experiments with a magnet for the monks during their recreation.[24] This should be apparent too when later we look at the quality of his Traité.

Rohault's influence is put in context if we glance at the reasons for the spread, not necessarily the acceptance, of cartesianism in France. Theological upheaval, disputes at home and abroad, the fervour of individual disciples, the whims of polite society, the vulgarisation of Descartes' philosophy in literary form, the availability of Descartes' works and the vigour of the group in Paris all played their part. Rohault's fulcrum was the group in Paris. But the leader of this school was Claude Clerselier, inasfar as any

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[24] Baillet, Vie de Descartes, II, 442. In my search for material on the 1667 celebrations I was unable to do more than verify some of what Baillet and Charles Adam have written. I discovered no material on Rohault's role in the celebrations. See Appendix 4 for a list of sources consulted.

individual can be said to have co-ordinated its actions and acted as its public relations officer.

Fedé described Clerselier as "this illustrious man whose perfect knowledge of Descartes' works makes all cartesians look on him as their master".[25] Baillet said that he "passe...pour le second auteur du Cartésianisme".[26] And the Nouvelles de la République des Lettres depicted him as "le plus grand Cartésien qui fût au monde...il avoit plus de zèle pour ce parti que M. Descartes luy-même".[27]

Clerselier was well equipped to assume leadership of the cartesian school. Friend and correspondent of Descartes, translator, editor and publicist of Descartes' works, he encouraged, cajoled and provoked whoever might support the cartesian cause.[28] During Descartes' lifetime he had had the privilege of translating the Objections and Answers to the Méditations,[29] had entertained Descartes when he came to Paris,[30] and from 1645, wrote to him regularly, posing

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[25] Les Méditations Métaphysiques..., Paris, 1673, Au Lecteur, not pag.

[26] Baillet, Vie de Descartes, II, 241.

[27] Nouvelles de la République des Lettres, vol. 1, 2e édit., Amsterdam, 1686, Extrait d'une Lettre écrite à l'Autheur de ces Nouvelles touchant M. Clerselier, Juin 1684, p. 433.

[28] Rohault, La Forge, Poisson, Desgabets and Florent Schuyl among others.

[29] see Correspondance de Descartes, ed. C. Adam and G. Milhaud, 8 vols., Paris, 1936-63, VI, 219-21; VII, 218.

[30] ibid., VI, 167 note 4; VIII, 222.

difficulties on the Holy Sacrament, the Passions de l'Ame and "L'Achille de Zenon".[31]

Clerselier was unswervingly and ruthlessly committed to the propagation and defence of cartesian philosophy. He edited three volumes of Descartes' Lettres (1657, 1659 and 1667), L'Homme...et un Traitté de la formation du foetus...avec les remarques de Louis de La Forge (1664) and L'Homme...et...Le Monde (1677).[32] In the prefaces to these he explained how he had organised and ordered Descartes' letters,[33] had been reduced sometimes "a deviner ce que l'Autheur avoit voulu dire",[34] had corresponded with J.B. Morin,[35] Henry More[36] and Henry Le Roy,[37] had unsuccessfully appealed to Roberval for copies of Descartes' letters to Mersenne[38] and had

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[31] ibid., VII, 24-5; VIII, 222-5, VII, 84-7.

[32] He also edited and published at his own expense, Les Principes de la Philosophie..., 4e édition reveue et corrigée fort exactement par C.L.R., Paris, 1681.

[33] O.D., V, 622-3.

[34] ibid., 622. Clerselier in some cases had only the minutes of Descartes' letters to work from. When he edited these, he rewrote the letters, emphasizing Descartes' piety. See Descartes, Oeuvres Philosophiques, ed. F. Alquié, T.I, Paris, 1963, p. 11.

[35] O.D., V, 623-4.

[36] loc. cit.

[37] ibid., 625-7.

[38] ibid., 649.

arranged for Gutschoven and La Forge to illustrate L'Homme.[39] He promoted and publicized current events in the cartesian world; his own defence of Descartes' character and work,[40] Rohault's conferences,[41] Le Laboureur's poem, Charlemagne,[42] the work of La Forge[43] and D'Alibert's plan to return the body of Descartes to France.[44] At every opportunity he clearly and publicly expressed his hope that Descartes' doctrine would be received in France "avec plus de succez et plus d'aplaudissement qu'en aucun lieu du monde".[45]

Not so public was his ambition to publish Descartes' views on the Eucharist: "c'est le dernier travail auquel je me destine pour mettre fin a tous les ouvrages de Mr. Descartes et pour cela j'auray besoin du secours de tous mes amis".[46] To this end he wrote to a number of theologians; Père Viogué, Père Berthet, Antoine Vinot,

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39 O.D., XI, preface to L'Homme, p.xvi. Clerselier added "...et mesme ils n'ont pas désaprouvé quelques petits avis que je leur ay donnez..." (p. xviii).

40 O.D., V, 481-5, 641-5, et passim.

41 ibid., 630.

42 ibid., 638.

43 ibid., 651-2.

44 ibid., 652.

45 ibid., 621.

46 Chartres, 366, Clerselier à Bertet, 27 Août 1659.

Robert Desgabets, Nicolas Poisson; and attempted to win support for Descartes' views.[47] Unsuccessful, he still continued to proselytize, calling to his aid Dom Robert Desgabets and eventually, with calamitous results, Rohault.[48]

Rohault's position within the cartesian school tended to be subordinate to that of Clerselier if only because he had not known Descartes personally and had not inherited Descartes' papers. This subordination expressed itself in the tactics that each man employed to win acceptance for cartesianism. Rohault was less aggressive and less outspoken than Clerselier as we can see from his declaration to Nicloas Poisson:

> "J'estimerois qu'il suffiroit d'enseigner les premiers elemens de la philosophie de M^r Descartes...et pour le surplus ceux qui seront un peu initiez y tomberont d'eux mesmes."[49]

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[47] See Chartres, 366. Clerselier corresponded with Viogué, Descartes' confessor in Sweden, in 1654, with Bertet in 1659, with Vinot in 1660 and 1664, with Desgabets 1663-73 and with Poisson in 1667.

[48] On Christmas Eve 1671 the Archbishop of Paris, François de Champvallon, told Clerselier that he and Rohault should bring to an end their campaign promoting Descartes' interpretation of the Eucharist, (see Chapter X). In 1682, Clerselier recounted how Rohault, on his death-bed, was interrogated by Nicolas Blampignon, Curé de S^t Médéric, "en presence de toute la compagnie qui assista à cette pieuse et triste ceremonie, sur les principaux articles de nostre croyance" and asked to make a public declaration of his catholicity, confirming his belief that in the Eucharist there was a real transubstantiation of the bread and wine into the body and blood of Christ. (Rohault, Oeuvres Posthumes, preface).

[49] Honfleur, Fonds Adry (15'11) 4, fol. 35.

Nonetheless, the efforts of Clerselier and Rohault were complementary rather than antagonistic. "The two pillars of the sect"[50] were concerned mainly with different but related areas of cartesianism, Clerselier with metaphysics, Rohault with physics. The difference of emphasis meant that they worked in harmony yet retained a degree of independence, an independence which Rohault secured by his conferences and his Traité de Physique. Fontenelle claimed that Rohault converted Pierre Sylvain Régis to cartesianism and in four or five months prepared him for "une espèce de Mission" to Toulouse.[51] The Traité de Physique gave Rohault lasting fame and extended his reputation far beyond the Parisian scientific élite.

After his death, Rohault's Traité became a classic exposition of cartesian physics and the handbook of students of Newtonian and Cartesian science. Acclaimed throughout Europe till mid-eighteenth century, it was admired by Leibniz,[52] used by Huygens,[53] by Pierre Sylvain Régis in his Système de Philosophie,[54] by Claude Gadrois,[55]

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[50] Mémoires of the Life of P.D. Huet, Bishop of Avranches, trans. J. Aiken, 2 vols., London, 1810, II, 353.

[51] Oeuvres de M. de Fontenelle, nouv. édit., 11 vols., Paris, 1766,V,137.

[52] G.W. Leibniz, Philosophischer Brefwechsel, Bd.1, Darmstadt, 1926, p. 154.

[53] see, for example, O.H., XIII^2, 742; XIX, 572; XXI, 446.

[54] P.S. Régis, Système de philosophie contenant la logique, la métaphysique, la physique et la morale, 3 vols., Paris, 1690. Y.M. André cuttingly remarked in his Vie du P. Malebranche that Régis' "physique est assez bonne dans la plupart des endroits, où il a copié M.D., M. Rohaut etc..." (Oeuvres de Malebranche, XVII-I, 247).

[55] C. Gadroys, Le système du monde selon les trois hypothèses..., Paris, 1675. See P. Mouy, La Physique cartésienne, p. 142.

Pierre Bayle in his philosophy course at Sedan and Rotterdam,[56] by Pierre Villemandy at Saumur[57] and by Nicolas Malebranche in his Recherche de la Verité.[58] In 1691, Dom Jean Mabillon prescribed "Mr Rohault sur la philosophie de Descartes"[59] in his book list for Benedictine philosophy and theology courses and in his 'catalogue of the best books for an ecclesiastical library'.[60] In 1709 Malebranche recommended Rohault's Traité to Y.M. André who had asked him "...quelles sont les meilleurs livres dont je puisse m'aider dans un cours de philosophie".[61]

The Traité became a textbook for students and teachers in schools and universities in the United Provinces, the Low Countries, England, Germany, France and America. It appeared in French, Latin

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[56] Oeuvres Diverses de Pierre Bayle, 4 vols., La Haye, 1727-31, IV, Système de Philosophie, Avertissement, 309, 420, 422.

[57] Manuductio ad Philosophiam, Aristoteleam, Epicuream et Cartesiam authore Petro de Villemandy..., Saumur, 1678, p. 75. Cited in J. Prost, La Philosophie à l'académie protestante de Saumur, Paris, 1907, p. 110. Villemandy taught philosophy 1669-83.

[58] Oeuvres de Malebranche, I-III, Recherche de la Verité, ed. G. Rodis-Lewis. See the editor's notes, II, 361 and note 233 p. 554, II, 403 and note 292 p. 560 et passim.

[59] Dom Jean Mabillon, Traité des Etudes Monastiques, Paris, 1691, p. 347.

[60] ibid., pp. 645-8.

[61] Bibliothèque de Caen, Ms 116, fols. 232-3. Cited in Oeuvres de Malebranche, XIX, 795.

and English and was reprinted more than 25 times between 1671 and 1739 in London, Leyden, Amsterdam, Cologne, Geneva and Paris.[62] Its long life and success, however, depended not only on Rohault's masterly synthesis and encyclopaedic exposition of Descartes' physics, his modesty and tactful appraisal of the value of the Ancients and the clear, 'mathematical' and 'mechanical' presentation of his arguments. It depended too, in England and in the American colonies at least, on the Samuel Clarke editions which supplied Newtonian footnotes contradicting the text.

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[62] The best account of the various editions of Rohault's Traité de Physique is found in M.A. Hoskin, " 'Mining All Within': Clarke's notes to Rohault's Traité de Physique", The Thomist, XXIV, 1961, pp. 353-63, p. 353 note 4.

Here is the list of editions with a few minor changes:

French editions, published in Paris: 1671(1st ed.), 1672(2nd ed.), 1676/5 (3rd ed. corrigée), 1676 (4th ed., reveüe et corrigée), 1682 (4th ed., tres-exactement reveüe et corrigée), 1705, 1708(12th ed.), 1723, 1730.

French editions published in Amsterdam: 1672, 1676.

Latin translation by Bonet: 1674, Geneva; 1682, London; 1682, Amsterdam, with notes of Le Grand; 1700, Amsterdam, with notes of Le Grand.

Latin translation by Clarke and with his notes: 1697 (1st version of notes), London; 1702 (2nd version), London; 1708 (2nd version, with notes of Le Grand), Amsterdam; 1710 (3rd version), London; 1713 (2nd Latin ed. of 'Mechanics' etc., with notes of Le Grand), Cologne; 1718 (3rd version), London; 1739, "6th edition", Leiden.

English translation of John Clarke with 4th version of Samuel Clarke's notes: 1723, London; 1728/9, London; 1735, London.

Poggendorff mentions an edition with Clarke's notes printed in 1701 and the Allgemeines Buche-Lexicon (Leipzig, 1793) mentions another, with Clarke's notes, published at Leiden, 1729. G. Varet, Manuel de Bibliographie Philosophique, 2 vols., Paris, 1956, I, 376, adds Traité de Physique, 4e édit., Paris, 1681 and describes the Traité de Physique, 12e édit., Paris et Bruxelles, 1708, as "un faux".

CHAPTER IV

A DESCRIPTION OF HIS SCIENTIFIC PUBLICATIONS

Rohault's published work in the natural sciences consists of the Traité de Physique and Oeuvres Posthumes. Instead of making a critical analysis at this point, we attempt here to remain true to the way Rohault himself described his physics and mathematics. However, a summary of thirty pages can do no more than describe the essentials of his arguments, which are both intricate in structure and illustrated by many explanatory examples.

The Traité de Physique was the mainstay of Rohault's reputation, the work which was magnificently successful in the seventy years after his death and the principal reason why he was acknowledged in the eighteenth century by Voltaire,[1] Condorcet[2] and Saverien,[3] in the nineteenth by Bouillier[4], and in the twentieth century by

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[1] see Oeuvres Complètes de Voltaire, Siècle de Louis XIV, nouv. édit., 41 vols., Paris, 1817-1818, XIII, 147. Voltaire wrote of Rohault: "il exposa avec clarté et méthode la philosophie de Descartes...".

[2] Oeuvres de Condorcet, ed. A. Condorcet O'Connor and M.F. Aragne, 12 vols., Paris, 1847-9, Eloge de Rohault, II, 94-6.

[3] A. Saverien, Histoire des Progrès de l'esprit humain dans les sciences exactes, et dans les Arts, Paris, 1756, pp. 265-6. Histoire des Philosophes Modernes, VI, 1-22.

[4] F. Bouillier, Histoire de la philosophie cartésienne, 2 vols., Paris, 1854. Histoire et critique de la révolution cartésienne, Lyon, 1842.

Gautier[5] and Paul Mouy.[6] In the preface Rohault described how he had divided his work into four parts: "...du Corps Naturel...du Systhème du Monde...la Nature de la Terre et des corps Terrestres... le corps Animé."

Part I, on 'natural bodies in general', begins with an injunction to submit all our ideas and knowledge to a fresh examination. First, the metaphysical preliminaries: how do we know of the world's existence? Rohault commences by syllogistically proving the existence of his own soul or mind, "Je pense; pour penser il faut estre; donc je suis".[7] Or expressed more elaborately, innate reason teaches us that nothing has no properties; thinking is a prpperty; whatever thinks therefore exists.

Our knowledge of the external world comes by our using "the different ways of knowing that are in us".[8] There are four of these ways, conception or simple perception, judgement, reason and sensation, none of which alone can give sufficient assurance of a thing's existence. Our method seems to have been:

> "Premièrement nous avons senty: puis nous avons remarqué que nous ne sentions pas quand nous voulions, et que nous sentions mesme quelquefois quand nous ne voulions pas: et delà nous avons conclu que nous n'estions pas la cause totale de nos sentimens; Que nous contribuions bien en partie pour les avoir, mais que nous dépendions aussi de quelque autre chose; et ainsi nous avons commencé à connoistre que nous n'estions pas seuls, et qu'il y avoit plusieurs autres Estres qui existoient avec nous dans le monde."[9]

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[5] A. Gautier, "Un précurseur Français de la science expérimentale moderne, Jacques Rohault", Revue Générale des Sciences pures et appliquées, XXVI, 1915, pp. 267-72.

[6] P. Mouy, Le Développement de la Physique Cartésienne, Paris, 1934.

[7] J. Rohault, Traité de Physique, Paris, 1671, Part I, chapter 2, p. 4.

[8] ibid., I, 2, 5.

[9] ibid., I, 2, 15.

It is a mistake, however, to believe that our senses alone present us with a true picture of reality. "All that they can do is be the occasion of knowing existents. It is principally by reasoning that we are assured of their existence."[10]

Rohault's physics is mathematical in the Euclidean sense of defining one's terms, stating axioms and deducing the necessary consequences.[11] In the chapter 'Avis touchant les Mots'[12] he defines only the terms which he understands clearly and distinctly. Being is that which exists, substance a being that we conceive to subsist independent of all other created Being. The essence of a thing is its nature, that which makes it what it is. Thus, the essence of a triangle is that it is a figure terminated by three straight lines. An essential property of a thing is that which we conceive to belong to a thing and is a necessary consequence of its essence. The three angles of a triangle, for example, are equal to two right angles. An accidental property or accident is that which we do not think necessary to it but which belongs to it only accidentally. Thus the blackness of a triangle is an accident since a triangle does not have to be black to be a triangle. He then enumerates the principal axioms of his physics.[13] Nothingness has no properties; it is impossible for something to be made of absolute nothing or pure

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[10] ibid., I, 2, 15-16.

[11] Later, it becomes obvious that his physics is also mathematical in so far as the properties which he assigns to matter are quantifiable.

[12] Rohault, Traité, I, 4.

[13] ibid., I, 5.

nothing become something; a thing or a substance cannot be completely destroyed; every effect presupposes a cause; if we do not cause an effect, it must depend on some other cause; everything has to continue in its present mode of being; every change is made by an external cause; a change is always proportional to the force of the agent which causes it.

Having laid the foundations, Rohault begins to construct his physics. Using the example of what happens when wood is converted into fire, he concludes that the two principles of natural things are matter and form.[14]

The essence of matter is extension since we have the idea of this before its three essential properties; divisibility, figure and impenetrability. 'Hardness, liquidity, heat, cold, gravity, levity, taste, smell, sound, light, colour, transparency, opacity etc.' are accidental properties since matter may exist without any of them.

From this doctrine and distinction between primary and secondary qualities Rohault infers the following; that "the vacuum of the philosophers is impossible".

> Car par le vuide ils entendent un espace sans matière, et chez nous espace (ou estendüe) et matiere ne sont que la mesme chose; si bien que de demander s'il peut y avoir un espace sans matiere, c'est demander s'il peut y avoir une matiere sans matiere; en quoy il y a une manifeste contradiction.[15]

Internal place or the space that each body occupies, does not differ from the body itself. When we say a body changes its place we mean its external place, that is, with regard to the surfaces of other bodies which surround it. Rarefaction and condensation of a body

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[14]ibid., I, 6, 33-4.

[15]ibid., I, 8, 41.

are explained by the entry and exit of subtle matter through the body's pores. The world is 'indefinite'. There cannot be several worlds. Since we do not have an idea of the extension of the heavens other than the extension of terrestial things we ought to judge that they are "d'une mesme espece".[16] Two equal masses contain an equal quantity of matter.

The divisibility of matter presupposes motion: "...afin qu'une portion de matiere soit actuellement divisée de celle à laquelle elle estoit unie, il faut necessairement qu'elle s'en sépare...".[17] Motion consists in the successive application of a body to the different parts of those bodies which surround it. Hence rest is the continual application of a body to the same parts of those bodies which surround it. Both motion and rest are accidental to matter. We may suppose that God created a certain quantity of motion but Rohault avoids this subject, "nous ne nous arresterons (donc) pas à raisonner sur ce sujet".[18]

Rohault then enunciates his laws of motion and laws of shock for perfectly hard bodies.[19] Since God created and preserves a certain quantity of motion and since a body ought to remain always in the same state unless an external cause changes it, it follows that, a body in motion loses as much of its motion as it communicates to other bodies and loses less of its motion when it strikes against

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[16] ibid., I, 8, 45.

[17] ibid., I, 9, 55.

[18] ibid., I, 10, 62.

[19] ibid., I, 11-13.

another body already in motion than when it strikes upon a body at rest. Greater bodies continue to move longer than lesser ones. A body in direct motion makes other bodies turn in a circle.

Rohault draws a distinction between speed and determination. Determination he defines as the disposition of a body to move in a particular direction. Determination is a mode of being distinct from motion. Its quantity can remain the same while motion increases or diminishes. It is evident that a body:

> "qui a une fois commencé de se mouvoir avec une certaine détermination, le doit toújours garder; c'est-à-dire, qu'il doit toûjours décrire une ligne droite: puisque c'est la seule détermination qui soit naturelle d'un corps qui se meut." [20]

When a body moves in a circle it is forced to do so, but once that force ceases, it ought to move in the tangent of that circle. Bodies which move in a circle tend to go off from the centre of the circle which they describe and make other bodies approach it. A body in motion meeting another body which it cannot move, ought to be reflected, that is, change its determination but retain its original velocity. "The second determination may be contrary to the first; but because the notion we have of reflected motion is not different from that of direct motion, we ought to say that these motions are not contrary, that one is only a continuation of the other, and consequently, that there is no moment of rest in the point of reflexion...".[21] A body falling perpendicularly on another ought to be reflected perpendicularly.

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[20]Ibid., I, 13, 101.

[21]ibid., I, 13, 103.

The second principle of natural things is form. The form of any thing is that which makes it be that particular thing. Rohault argues that the example of the rational soul does not prove the existence of substantial forms:

> Car quoy que nous sçachions que c'est une substance réelement distincte du corps auquel elle est unie, et qu'elle n'en dépend aucunement pour estre, cela ne peut tirer à consequence pour les formes des autres estres purement materiels.[22]

He admits, however, 'essential'forms, that is, those which belong necessarily to their subjects. Liquidity, for example, is essential to water.

Forms consist in the figure, rest and motion of the parts of a body. The simplest of all are the forms of the Elements. The three elements are: particles of a very fine subtle matter ("cette poussière très subtile");[23] rounded, medium-sized globules of matter; and gross matter "sous des figures irregulières et embarassantes, et peu propre au mouvement".[24] Rohault believes in the existence of these three elements, "estant certain qu'elles suivent necessairement du mouvement et de la division des parties de la matiere, que l'experience nous oblige de reconnoître dans l'Univers".[25]

Other forms like hardness, liquidity, heat, cold, smell, light and colours, are sensations raised in us by the figure and motion of the parts of particular bodies. Rohault gives 'a long and detailed

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[22]ibid., I, 18, 127.

[23]ibid., I, 21, 148.

[24]loc. cit.

[25]ibid., I, 21, 150.

explanation of all the sensible qualities' in order to free his reader from anthropomorphic prejudices, that is, 'of attributing sensations to objects which cause them and considering these sensations as qualities in the objects'.[26]

Rohault's 'long and detailed explanation' is primarily an experimental and mechanistic illustration of cartesian theory. Hardness, for example, "c'est estre composé de parties qui sont tellement en repos les unes auprès des autres...".[27] Liquidity "consiste dans l'agitation continuelle des parties insensibles du corps liquide".[28] Thus the agitating parts of certain liquids are able to dissolve the parts of certain hard bodies by shaking and moving them so as to force them out of their places. Conversely, when agitation ceases, as for example after evaporation, the remaining parts of a solid unite to form crystals. Evaporation is explained by a high degree of agitation dispersing the parts of a liquid body and making them fly into the air. Congelation occurs when there is only a faint agitation. "Le ressort" or springiness of a body is explained by the passage of subtle matter through its small pores. A plate of untempered steel beaten on an anvil when it is cold, will acquire, as the workmen say, a 'power of springing' because the beating makes the parts approach one another and straightens the pores. The heat of a body consists in 'a peculiar motion of its particles' (a circular motion about their own centres), whereas we

[26] ibid., preface, not pag.

[27] ibid., I, 22, 155.

[28] loc. cit.

feel the cold when this particular motion ceases. Thus the friction caused by rubbing our hands together causes heat and "thus marble having more particles at rest than wood, which has more pores and is full of a liquid matter which is in continual motion, ought to feel colder than wood".[29]

Rohault's theories of vision, light and colours are similar to those expressed in Descartes' Dioptrique.[30] 'Primitive' Light, the light source, consists in "un certain mouvement des parties du corps lumineux, qui les rend capables de pousser à la ronde la matiere subtile qui remplit les pores des corps transparens".[31] 'Secondary or derivitive' light, that which we perceive, is "l'inclination à se mouvoir, ou la tendance qu'a cette matiere à s'éloigner en ligne droite du centre du corps lumineux".[32] Because secondary light does not consist in the actual movement of the subtle matter which fills the pores of transparent bodies, but only in its inclination to move, it follows that the luminous body, no matter how far away it is, ought to make itself felt in an instant "à cause que cette matière qu'il pousse est continuëment étendue",[33] a point which is illustrated

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[29] J. Rohault, A System of Natural Philosophy, trans. J. Clarke, illustrated with Dr. Samuel Clarke's Notes..., 2 vols., London, 1723, reprinted New York and London, 1969, Part I, chapter 23, p. 166.

[30] see O.D., VI, 81-227.

[31] Rohault, Traité, I, 27, 271.

[32] loc. cit.

[33] ibid., I, 27, 277.

further by analogies with liquid pressure and the shaking of a very long stick. Thus Rohault, like Descartes, conceives light to be an inclination to move and rays of light to be "the lines along which this inclination tends".[34] Consequently, an infinity of rays, passing from the parts of the luminous body to those which they illuminate, through a single uniform medium, are to be regarded as straight.

We perceive coloured objects because of the different ways in which bodies receive light and send it to our eyes.

> "...il est aisé à juger que c'est elle [la lumière] qui agit sur notre organe pour nous faire sentir quelque couleur, et que toute l'action du corps coloré consiste à la renvoyer avec quelque modification qu'elle n'avoit pas quand il l'a receuë."[35]

White is seen when little modification happens to the rays of light reflected from a body with a rough surface. When no light falls on a body whose parts are "fort delicates et fort interrompuës",[36] when opaque bodies intervene, or when a well polished body reflects the rays of light to the side opposite to us, these bodies appear black. Sometimes, as in a glass prism, particles of the second element which transmit light are 'refracted' from an object spinning about their own centres at different speeds. According to the proportions which exist between the direct and spinning motions of the particles, the rays of light appear different colours. If the rotary motion is very rapid compared with the direct, the body

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[34] O.D., VI, 88, and Rohault, Traité, I, 27, 305.

[35] Rohault, Traité, I, 27, 291.

[36] ibid., I, 27, 294.

appears red, if less so, it appears yellow and if even less again, it appears blue.

In the final chapters of Part I[37] Rohault finishes his theory of vision by tracing the passage of light from an object through the eye to the retina, the communication of the image to the brain, and explains how we know the situation, distance, magnitude, figure and mobility or immobility of the visible object.

Part II COSMOGRAPHY

Rohault's treatment of the 'System of the World' meets his high standards of simple and lucid exposition. He describes how the hypotheses of Ptolemy, Copernicus and Tycho Brahe explain the appearances of sun, fixed stars, moon and planets, illustrating the Ptolemaic heliocentric and Copernican geocentric systems by two diagrams (see p. 68). He then analyses the three systems and states his reasons for rejecting the hypotheses of Ptolemy and Tycho and for accepting the Copernican.

Ptolemy's hypothesis is rejected because it is experimentally and logically falsifiable and aesthetically displeasing.[37a] It is contradicted by Galileo's observations of the phases of Venus. Ptolemy's system, instead of being deduced from a small number of suppositions,is cluttered with a great number "which are made upon all occasions".[38] It introduces oscillations in the crystalline

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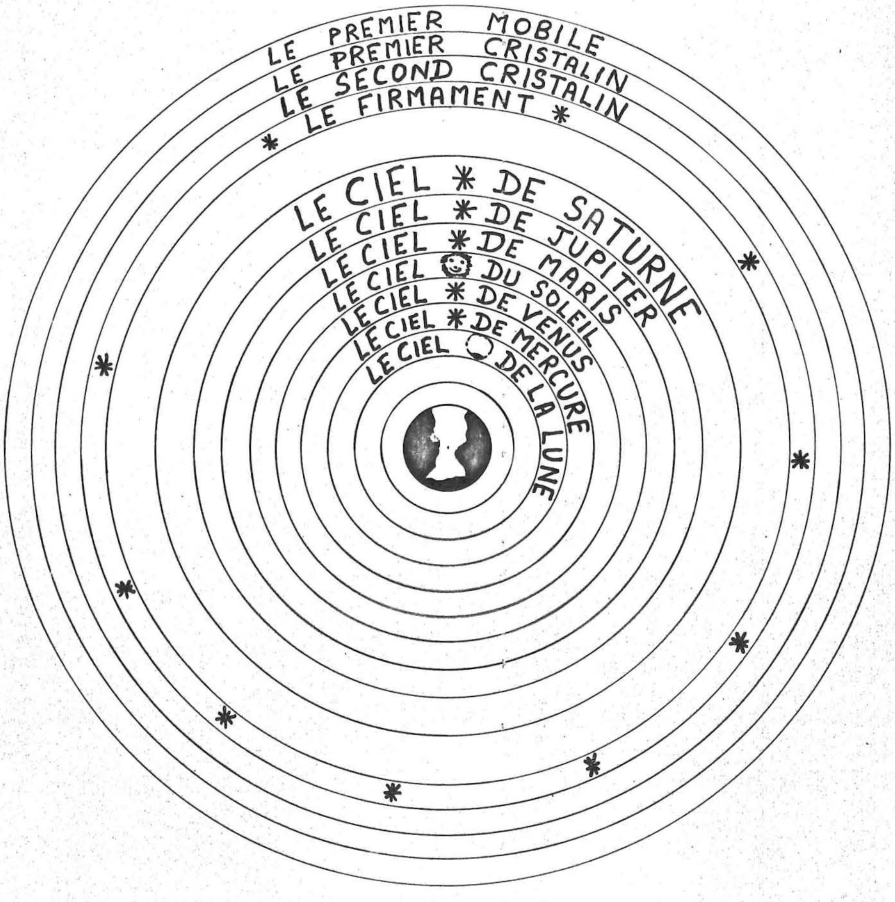
[37]ibid., chpts. 28-35. cf. O.D., VI, 105-47.

[37a]in the sense that it denies Ockham's razor.

[38]Rohault, System, II, 24, 60.

FIG. 1 SYSTHEME DE PTOLOMEE



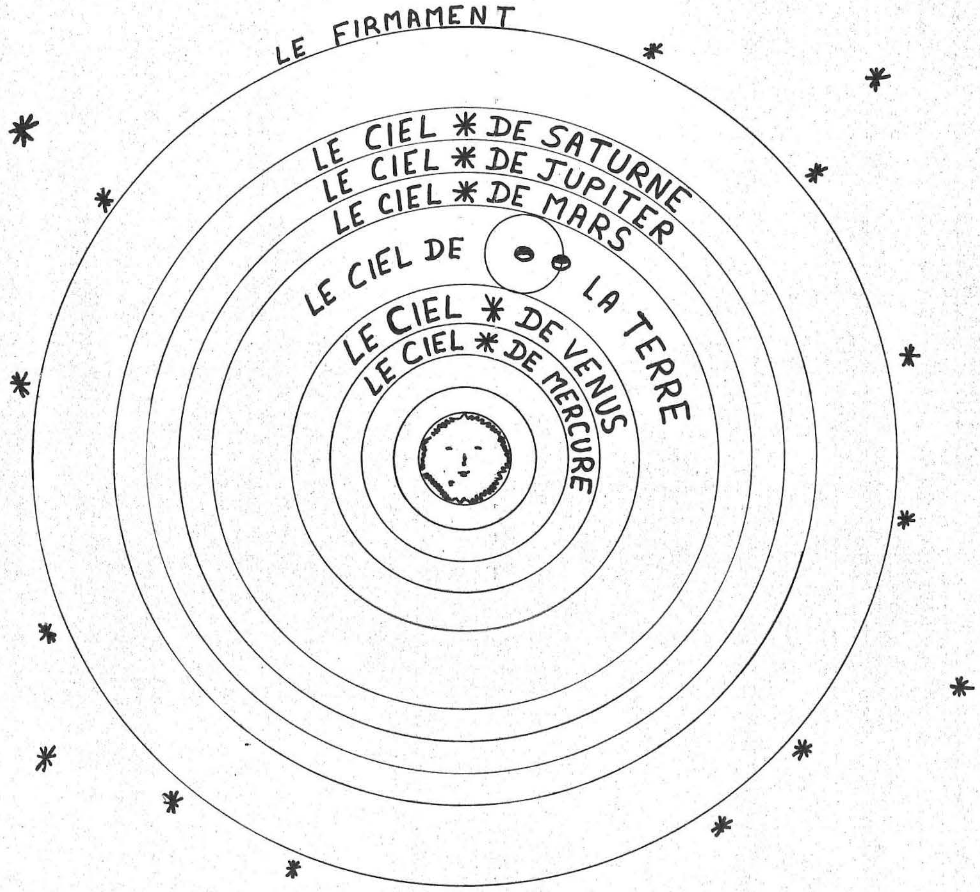


FIG. 2 SYSTEME DE COPERNIC

heavens, admitting a great change to explain a small one. The oscillation which he uses to explain the unequal motion of his fixed stars only confuses the calculations of astronomers. When he says that the Primum Mobile carries the heavens from east to west there is no reason to suppose that the Earth is not carried also from east to west. The argument that the earth's gravity hinders it from being moved by the heavens which encompass it is a false one. For, says Rohault, 'all that experience teaches is that gravity is a quality by which terrestial bodies tend to the centre of the earth and tend to unite with each other'.[39] It would be absurd to say that gravity hindered the earth's motion "as it would be to affirm that a number of persons who are in a boat, that turns round, can stop themselves from being turned by clasping each other and fastening themselves together as close as they can".[40] Finally, Ptolemy's hypothesis cannot be true since it cannot explain either gravity and levity or the ebb and flow of the sea.

Tycho's hypothesis that the planets revolve round the sun and stars revolve round the earth is better than that of Ptolemy and "accounts very well for the apparent phases of Venus".[41] But it cannot be reconciled with reason since the two motions it supposes are contradictory. According to the laws of nature, the motion of "la masse composée des cieux des planètes" (ie: of the matter of the planetary heavens) must gradually diminish and stop because

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[39]ibid., II, 24, 60.

[40]loc. cit.

[41]ibid., II, 24, 61.

it must be imparted to the caelestial matter (ie: of the starry heavens) which is gradually being turned out of its place.[42]

The Copernican hypothesis is declared to be the true one. It provides the simplest explanation of the phenomena and is supported by experiment. Observations of Mars, Jupiter and Saturn have shown that these three planets receive their light by revolving round the sun and possibly by turning about their centres. The objection to the earth's motion, that a stone released from above should land to the west of where it was released, is of no account. Because all terrestial bodies turn with the earth from west to east and because all bodies must continue in the state in which they are, the stone moves forward exactly as much as the earth does and falls on the place which corresponded to it perpendicularly when released.

In the remaining chapters,[43] Rohault completes his cosmography explaining the nature of the stars and comets, the ebb and flow of the sea, gravity and levity, by using Descartes' vortex theory.

Part III <u>OF TERRESTIAL BEINGS</u>

Part III treats of the earth and terrestial bodies - earth, air, water, fire, salts, oils, metals, minerals and 'meteors'. Once again, explanation of the nature and properties of phenomena is based on cartesian theories of matter and motion. Rohault ingeniously applies these theories to physical reality and gives them what he believes is empirical and 'artistic' ratification.

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[42] loc. cit.

[43] ibid., II, 25-29.

The nature and properties of the earth and of the bodies which surround it are close enough to be examined by our senses and can be discovered in diverse ways. Daily experience and the observations of the past confirm us in the opinion that the earth is in a continual state of change. As far as this change depends on the action of the things which surround the earth, there is hope of knowing the earth's nature by reasoning on what ought to result from the action of the matter in the vortex which has the earth as its centre.

The earth is composed of particles of the third element "que leur grosseur jointe à leur peu de solidité et leurs figures embarrassantes, rendent moins propres et moins disposées à se mouvoir que les autres".[44] These particles are similar to those of which sun spots are composed, except that they are more narrowly united and bound together and by this means form a body which is "plus dense et plus épais".[45]

The irregularities of the earth's surface are explained by the irregular figure of the particles of the third element. The earth must be almost round because any protruding part would have been worn down by (the) liquid matter (of its vortex) beating violently against it. Its hardness and dryness result from the relative rest of its parts. It is cold because there is not enough motion in its parts to excite heat. It is heavy "parce que ses parties ayant moins de force que les autres à s'éloigner du centre du tourbillon

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[44] Rohault, <u>Traité</u>, III, 2, 143.

[45] loc. cit.

où elle est, y doivent estre repoussées".[46] It is opaque because of the interruption and detours of its pores.

In the 'interior earth' there are three sorts of pores: those that turn and bend every way and go along like waves, those that are perfectly straight and those that communicate with each other and are twisted together to resemble the branches of a tree. There is, in addition, a fourth type of pore where subtle matter descends towards the poles of the earth in the form of a screw:

> ...ces pores...sont comme autant d'écroüës paralleles entr'elles et que celles de ces écroüës, qui reçoivent la matiere canelée qui vient du pole Arctique, sont tournées à contresens de celles par où passe la matière canelée qui descend du pole Antarctique.[47]

Salt is

> un amas de plusieurs petites parties longues et droites, chacune desquelles est composée de la matière du premier Element qui s'est figée, et qui a pris la forme qu'elle a, en passant par les pores longs et droits que nous sçavons se rencontrer principalement dans la Terre Interieure.[48]

It is more solid, more transparent, harder to freeze and heavier than water. It melts when exposed to vapours in the air. Its sharp taste comes from the long sharp points of its particles shaking the capillaments of the nerves of the tongue. Rohault adds to this list of the properties of salt by 'artistic' explanations of a

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[46] ibid., III, 1, 144.

[47] ibid., III, 1, 148. This description of the pores of the 'interior earth' lays the foundation for the explanation of magnetic impulsion given in III, 8.

[48] ibid., III, 4, 161.

" secret pour glacer de l'eau dans un lieu chaud",[49] why salt will not evaporate, how it serves to melt metals, how it is made in the salt marshes, why it crackles and melts easily in the fire, why the sea is most salted between the tropics and how to make the spirit of salt and convert it into a liquid (nitric acid).

His explanation of the rainbow follows that of Descartes.[50] Nonetheless, he proceeds by supposing that he is the first to find "la cause de ce Meteore".[51] Since we know by experience that when we see the rainbow the air is filled with transparent drops of colourless water, we ought to conjecture "que ce sont ces gouttes d'eau au travers desquelles la lumiere a souffert quelque refraction en passant, qui nous font sentir ces couleurs...".[52] To see if our conjecture is well or ill-founded we must consider what becomes of the sun's rays which fall on a watery body of a spherical figure, such as a drop of rain.

We can see that the primary, inner bow is caused by one reflexion and two refractions in the drops of water and that two reflexions and two refractions cause the secondary, outer bow. In figure 3 (see p. 74) the angle which N.P. makes with O.N., drawn from the sun's centre, is 41°30' and since the highest and lowest

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[49] ibid., III, 4, 164-5.

[50] see O.D., VI, 325-44.

[51] Rohault, Traité, III, 17, 288.

[52] ibid., III, 17, 289.

FIG. 3

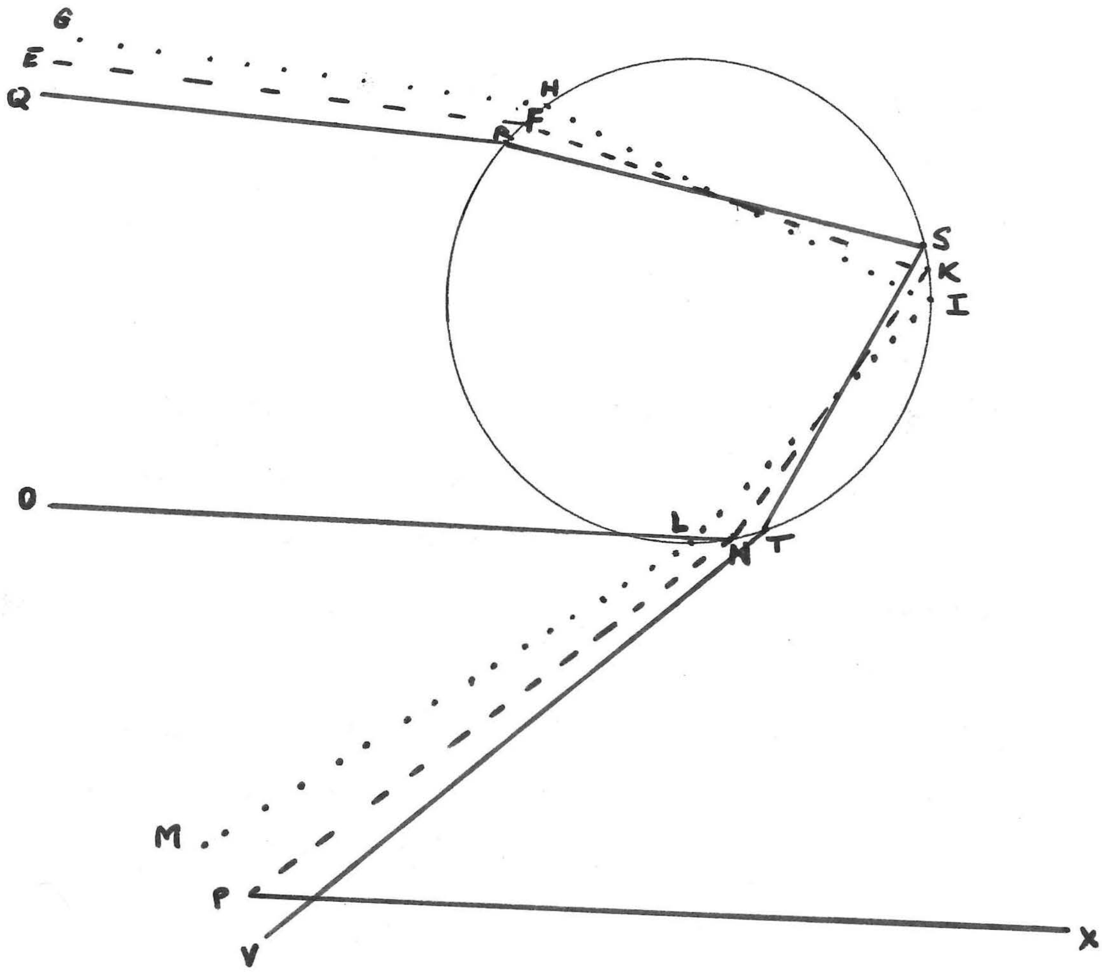
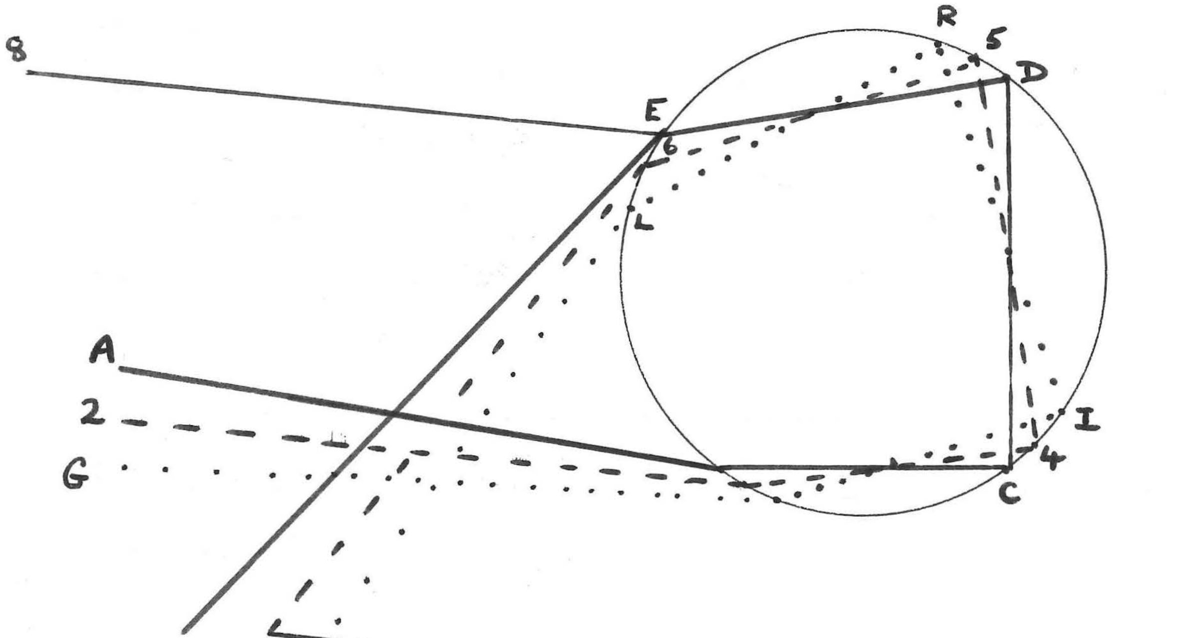


FIG. 4



effective ray is sixteen minutes higher and lower than E.F. ∠OLM is 41°14' and ∠OTV 41°46'. The ray T.V. is found to be red, L.M. blue and N.P. yellow. In the outer bow (figure 4, p. 74) the angle 867 is approximately 52° and the angles produced by the highest and lowest effective rays approximately 51°44' and 52°16'. The ray E.F. is red, L.M. blue and 6.7. yellow. Of all the sun's rays which are incident upon the drops of water only those which produce angles between 41° and 53° can raise any sensation in the observer. The others leave the drops as a divergent pencil. The rays of the inner bow produce stronger colours than those of the outer bow since they are weakened only three times at the points where they are broken or reflected, whereas the others are weakened four times at the points of reflexion and refraction.[53]

The conjecture, Rohault, argues, is confirmed by experiment and by the fact that all the observed properties of the rainbow can be deduced from it. If, for example, a glass globe three inches in diameter is filled with water and held to the sun and if we look from V (figure 3) the globe appears red at T. From P it appears yellow at N and from M it appears green or blue at L.[54]

Rohault then lists the properties of the rainbow and describes how they can be explained by his conjecture. For example, a rainbow is always of a certain breadth. It must be contained under an angle

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[53]This paragraph is based on Rohault, Traité, III, 17, 291-5.

[54]ibid., III, 17, 295-6.

of thirty-two minutes, "qui est la difference des angles sous lesquels nous avons montré qu'on doit voir les couleurs qui le bornent et qui le terminent".[55] Each spectator sees a rainbow of his own since he sees it under a certain angle about the axis of vision. He concludes the chapter and the third part with the confident statement, "il n'y aura aucune circonstance de ce Meteore tant peu considerable, dont nous n'ayons rendu une raison très evidente".[56]

Part IV <u>THE BODY OF MAN</u>

Part IV contains brief anatomical, physiological and pathological sketches of the 'Body of Man'. The first chapters[57] give a factual description of the interior of a boneless body - the brain, nerves and muscles, the heart, veins and arteries, the lacteal and lymphatic veins, the tongue and salival ducts, the lungs, liver, spleen, kidneys and bladder. The next chapters[58] describe the normal functioning of parts of this body - the motion of the blood, nutrition and growth, the animal spirits and motion of the muscles, respiration, waking and sleeping, digestion, the motion of the chyle, sanguification, the excretory system, hunger and thirst. The last two chapters treat sickness and health and fever.

In this part of the treatise the author's refutation of the

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[55] ibid., III, 17, 303.

[56] ibid., III, 17, 311.

[57] ibid., IV, 2-11.

[58] ibid., IV, 12-24.

opinions of the 'Ancients' is more vigorous and more explicit. He scathingly criticizes, for example, the 'Ancient' doctrine that the blood moves from the liver to the extremities of the body without circulating.

> Cette doctrine a esté receuë des Anciens sans aucune preuve, en des temps où l'on faisoit scrupule de douter que les premiers Philosophes eussent esté capable de se méprendre. Mais depuis qu'on ne se soumêt plus aveuglement à l'autorité dans ces sortes de matieres, et qu'on recherche les raisons que les premiers Maistres ont pû avoir pour les établir, l'on trouve que cette doctrine n'est qu'une pure imagination sans fondement, et qu'elle doit estre absolument rejetté.[59]

The description of the 'Body of Man' is well informed even if hurried and sketchy. The observations of Steno are used for a description of 'the disposition of the strands of a nerve which blend with the flesh to form a muscle and then unite again to make a tendon'.[60] Frequent references are made to recent anatomical experiments and discoveries: Asselli's discovery of the lacteal veins,[61] Pecquet's discovery of the reservoir of the chyle,[62] Gayant's dissection of a soldier who died in a drunken brawl demonstrating that the motion of the chyle was the same in men as it was in animals,[63] the discovery of the lymphatic veins[64] and the

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[59] ibid., IV, 12, 336.

[60] ibid., IV, 3, 321.

[61] ibid., IV, 6, 328 and 21, 364.

[62] ibid., IV, 6, 329 and 21, 365-6.

[63] ibid., IV, 21, 366-7.

[64] ibid., IV, 6, 329.

salival ducts,[65] Harvey's discovery of the function of the valves of the veins[66] and demonstration of the blood's circulation.[67]

Rohault's brief explanation of the blood's circular motion and its causes follows the mechanistic and diastolic explanation given by Descartes in the Discours de la Méthode[68] and La Description du Corps humain.[69] He is sufficiently aware of Harvey's work to quote some of Harvey's experiments[69a] to prove the blood's circulation and he even goes so far as to admit the possibility of the heart dilating and contracting in another way to what he has described. But he soon returns to an orthodox cartesian interpretation, stating that he "estime toûjours que c'est la dilation qui se fait du sang dans le coeur qui détermine ses actions".[70]

The treatise finishes on an optimistic note. Rohault looks forward to the accumulation of knowledge, particularly by the experiments of the Académie des Sciences, which he hopes he can use either to confirm or correst the principles of his physics.

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[65] ibid., IV, 7, 330.

[66] ibid., IV, 5, 327-8.

[67] ibid., IV, 12, 339.

[68] see O.D., VI, 49-50, 52-4 and Rohault, Traité, IV, 13, 342-3.

[69] see O.D., XI, 228 and Rohault, loc. cit.

[69a] See, for example, Rohault, Traité, IV, 14, 344 and Wm. Harvey, On the Motion of the Heart and Blood..., trans. R. Willis, in Great Books of the Western World, ed. R.M. Hutchins, vol. 28, Chicago, 1952, pp. 286-7. Rohault, Traité, IV, 13, 340-1 and Harvey, ibid., pp. 294-5.

[70] Rohault, Traité, IV, 13, 343.

OEUVRES POSTHUMES

In 1682 Clerselier published Rohault's mathematics treatises under the title Oeuvres Posthumes. The work did little to enhance Rohault's reputation among natural philosophers. The treatises were of an elementary standard, indeed were no more than what Rohault taught his mathematics pupils.[71] They are, nonetheless, an integral part of Rohault's make up and important for what they tell us of his mastery of his profession and how he valued mathematics.

The Oeuvres Posthumes is a collection of eight treatises: the first six books of Euclid's Elements, trigonometry, practical geometry, fortifications, mechanics, perspective, spherical triangles and arithmetic. Characteristic of the first treatise, on Euclid's Elements, as with the others, is the lucidity and thoroughness with which Rohault constructs his demonstrations. Beginning with the statement of his definitions, demands and axioms he progresses to what appears to the modern reader as a laborious geometrical exposition of his theorems, problems and their lemmas and corollaries. The first four Books of his adaptation develop the properties of plane figures; the triangle, the parallelogram, the square, the rectangle and the circle. Book five describes a general theory of proportion and Book six applies this theory to plane geometry. It includes a generalization of the Pythagorean theorem where three similar and similarly described figures are drawn on the three sides of a right angle.

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[71] see J. Rohault, Oeuvres Posthumes, Paris, 1682, preface, not pag., and Bibliothèque Municipale de Poitiers Ms. 170. It is possible that Rohault's maths. lessons were influenced by P. Herigone's Cursus Mathematicus ... Cours de Mathematiques, 6 vols., Paris, 1644.

> Prop. 31 Theo. 21 Si sur les trois costez d'un Triangle Rectangle sont décrites trois Figures semblables et semblablement posées, celle qui est décritte sur le costé qui soûtient l'Angle Droit, est égale aux deux autres.[72]

The second treatise, "Trigonometry or the Resolution of Triangles", is divided into three parts: 'On Lines that the Geometer applies to the Circle in various ways'; 'On the Construction of Sine, Tangent and Secant Tables'; 'On the Calculation of right-angled Triangles'. In part two, for example, Rohault constructs his sine tables by the method of different figures inscribed in a circle whose diameter equals 200,000 parts. The side of a hexagon is worth 100,000 parts because it is equal to the radius of the circle (by the 15th of the 4th of Euclid). The side of a triangle is worth 173,205 parts "car le Quarré du Costé d'un tel Triangle est égal a trois fois le Quarré du Rayon (par la 12 du 13). De sorte que si l'on prend trois fois le Quarré de 100000, et que de la somme l'on prenne la Racine quarré, ce sera la valeur du Costé du Triangle".[73] Then since the side of a hexagon contains 60° and the side of a triangle 120° it follows that subtenses of 60° are 100,000 parts and those of 120° are 173,205 parts. Divide by two and we have the sinus - of 30° ... 50,000 parts, of 60°... 86,602 parts and so on using other figures.

'Practical Geometry' is likewise divided into three parts; altimetry, planimetry and stereometry. Part one, entitled "De

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[72]Rohault, <u>Oeuvres Posthumes</u>, Les six premiers Livres des Elemens d'Euclide, VI, p. 296.

[73]ibid., La Trigonometrie ou la resolution des Triangles, p. 318.

l'Altimetrie ou de la Mesure des Hauteurs inaccessibles", describes how to measure, for example, a height perpendicular to the horizon, the size of a wall and the breadth of a river. In "De l'Arpentage ou de la Mesure des Surfaces" Rohault's propositions include "To measure the surface of a cone[74]...of a sphere[75]...To find the surface of a cylinder".[76] And in "Du Toise ou de la Mesure des Solides" he shows how to measure a right-angled parallelepiped,[77] a regular polyhedron,[78] bodies which contain a vacuum[79] and bodies which are highly irregular, such as a bunch of grapes.[80]

This treatise and the majority of the others support Clerselier's claim that Rohault was more interested in the usefulness of his mathematics and in finding means of teaching it than in those parts which are "d'une...grande et ...profonde spéculation, et abstraction...".[81] In the first proposition of part one, "to prepare an instrument to measure angles", Rohault describes in detail the construction of a graphometer and a method for marking degrees, minutes and seconds. He immediately makes known his interest in utility.

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[74] ibid., Part II, proposition XX.

[75] ibid., II, XXII.

[76] ibid., II, XXI.

[77] ibid., III, XXIV.

[78] ibid., III, XXXI.

[79] ibid., III, XXXIV.

[80] ibid., III, XXXV.

[81] ibid., preface, not pag.

> Chacun sçait que la Géométrie Speculative peut fournir divers moyens pour la Section des Angles; Mais comme tous ces moyens ne sont beaux pour la plus part que dans la Speculation, et qu'ils sont inutiles pour la Pratique; pour préparer nostre Instrument, il faut avoir recours à la Méchanique et suivre en cela les Voyes les plus courtes, les plus simples et les plus aisées à pratiquer.[82]

The treatise on fortifications is a treatise on military engineering. Rohault discusses the art of the 'ancient' methods of fortification, the invention of artillery, and the 'modern' methods of fortification of Errard, Marolois, the Chevalier de Ville and Comte de Pagan, adding his own criticisms, observations and recommendations. He employs his knowledge of physics, optics and ballistics and the mathematical proofs and principles he has established in previous treatises.

The task of the military engineer has changed with the nature of warfare. Gunpowder has been perfected, cannon have been developed,

> qu'on ne charge que d'un seul Boulet, lesquels portent incomparablement plus loin, et qui par consequent ont beaucoup plus de force que tous ces Cailloux et autres divers Corps dont on chargeoit les Bombardes; et au lieu que toute cette Feraille ne servoit qu'a tuer les Hommes, les Canons et les Boulets sont maintenant employez à ruïner et renverser les plus épaisses Murailles et les plus forts Bastions.[83]

It is these and like developments which have determined the design of fortresses. If, for example, it is known that a cannon-ball will penetrate "jusqu'à quinz piés de terre mediocrement battuë,

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[82]ibid., Trigonometrie, I, pp. 337-8.

[83]ibid., Traité des Fortifications, p. 378.

on jugea qu'il falloit faire les Parapets de trois Toises d'epaisseur".[84] Throughout the treatise he shows himself to be aware of the mundane problems of the military engineer: the condition of the soldiers, the time, money and tools available, the difference between 'the truth of speculation and the impossibility of practice'. The only sure way of drawing plans of an enemy fortress and of avoiding the inconveniences and optical distortions which result from making the attempt outside cannon range, for example, is for persons, who are thinking of serving in the army as engineers, to collect at their leisure the plans of whatever towns they think might be beseiged in the future.[85]

The 'Mechanics',[86] Archimedean in inspiration, describes simple machines, the balance, lever, pulley, wheel and axle, inclined plane, wedge and screw, by the method of the centre of gravity. Thomas Watts, in the preface to the 1716 English translation, wrote of this treatise: "it is not only exceeding clear and perspicuous and easy to be understood by Learners, as every Introduction ought to be, but it is also solid and substantial and goes to the very bottom of Things."[87] He said he planned to read it with his pupils

> "...as an easy Introduction to a thorough Understanding of Mechanicks and also as a kind of Praxis upon Euclid's Elements, exercising the Learner in the Use and proper manner of applying those Propositions which by themselves appear so dry and unentertaining to Beginners."[88]

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[84] ibid., p. 380.

[85] ibid., pp. 439-40.

[86] The 'Mechanics' was the most successful of Rohault's maths. treatises. It appeared in, J. Rohault, Oeuvres Posthumes, Paris, 1682 and idem, Oeuvres Posthumes, 2 vols., La Haye, 1690; it was appended to,

Its utility goes further than this, for Rohault deduces from his eighth proposition how to build a Roman balance[89] and gives advice on the construction of pulleys.[90] To minimise the resistance of the rope, axles and pivots he suggests that they be made as small and as fine as possible. The pulleys should turn with their axles in their blocks as this avoids rubbing and prevents the holes of the pulleys getting bigger which normally would hinder them from turning about their centres and cause them to malfunction. The treatise finishes with a brief sketch of the laws of hydrostatics which deal with the level of a liquid in a siphon and the force with which a liquid leaves a variety of tubes placed in different positions.

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86 (continued)
J. Rohaulti, Tractatus Physicus..., Amsterdam, 1700, ibid., London, 1708 and ibid., Cologne, 1713; and it was reprinted as, J. Rohaulti, De Arte Mechanica..., London, 1692, J. Rohault, Traité de Méchanique, 2 vols., n.p., 1723(?) and J. Rohault, A Treatise of Mechanics, Done into English...By T. Watts [with a recommendatory address by W. Whiston], London, 1716.

87 J. Rohault, A Treatise of Mechanics, London, 1716, preface, not pag.

88 loc cit. According to Watts, Humphrey Ditton used Rohault's 'mechanics' in his maths. school at Christ's-Church Hospital.

89 Rohault, Oeuvres Posthumes, pp. 509-10.

90 ibid., p. 538.

'Perspective' can be described as a short study of "an art which teaches us to represent visible objects as they appear to us"[91] or as treating the problems of depicting on the picture-plane objects in three dimensions as seen from a given station point. It might be considered as useful for the artist, engineer and architect, as an attempt to answer geometrically some of the problems of sense perception or simply as a mathematical exercise.

The final[92] treatise is a comprehensive course on 'Arithmetic'.[93] Once again it is evident from the clarity of expression and thorough treatment that Rohault was a teacher by profession. He divides the work into two parts, one on whole numbers, the other on fractions, basing each on the four principal rules of arithmetic: addition, subtraction, multiplication and division. These four rules are the foundations of the "la Règle de Proportion, la Règle de Trois, la Règle de Compagnie... d'Alliage... d'une fausse Position" and the extraction of square and cube roots.[94] He emphasises the utilitarian

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[91] ibid., Traité de Perspective, p. 595.

[92] In the penultimate treatise, 'La Resolution des Triangles Spheriques', Rohault defines a spherical triangle, states the fourteen principal theorems on which his demonstrations are built and then demonstrates five propositions, beginning with "Aux Triangles Sphériques Rectangles, il y a mesme raison de la Tangente de l'Angle opposé à la Perpendiculaire, à la Tangente de cette Perpendiculaire, qu'il y a du Rayon du Cercle au Sinus de la Baze" (p. 620).

[93] In the preface Clerselier said that he, himself, worked on this treatise "à le mettre en estat de paroistre au jour".

[94] ibid., Traité d'Arithmetique, Part 1, chapters I-III.

value of his subject matter. The end of the Arithmetician "...est de rapporter tout à l'Usage".[95] Arithmetical problems are related to the experience of "Un espicier... un orfèvre... un marchand de cinq sortes de vins ... Un Architecte ... Un Tapissier ... Un Marchand de Brocard ... un Maréchal de Camp".[96] But it is obvious too that he was very much taken with the study of mathematics for its own sake. He ends his work with what can only be described as a note of lyrical adulation for the grandeur of his 'science'.

> L'Arithmetique est une Science si vaste et si profonde qu'elle n'a ny fond ny rive; Et l'Esprit humain, tout grand et tout penetrant qu'il est, ne la sçauroit ny contenir ny épuiser; Il a beau se travailler et se tourmenter pour tâcher de la comprendre tout, quelque opiniastre et assidu que soit son travail, il n'en viendra jamais à bout; Elle luy fournira toujours de nouvelle matiere de quoy exercer sa curiosité;[97]

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[95] ibid., p. 647.

[96] ibid., p. 712, 715, 721, 771, 770, 735.

[97] ibid., pp. 776-7. This passage is so different from the style of the other treatises that I suspect it was written by Clerselier.

PART II

ROHAULT'S CONCEPT OF SCIENCE

INTRODUCTION

This part is devoted to three overlapping themes: Rohault's concept of science, his relationship with the Ancients and Moderns, and the major influences on his Traité de Physique. How he perceived system-building is important not only for a description of his concept of science but also because it informs us of the contest between Aristotle and Descartes in his Traité. The particularist appearance of the Traité provides an opportunity to examine another aspect of Descartes' influence and the influence of French experimentalists. Rohault's conception of the nature of his subject matter, his method and his purpose, while describing his 'regulative beliefs' and their impact on his approach to science, permit an assessment of his strengths and weaknesses as a natural philosopher.

Central to the scientific revolution of the sixteenth and seventeenth centuries, whether or not all of its participants were aware of it, was the substitution of one world-view for another. The Ptolemaic-Aristotelian view was replaced, eventually, by that of Isaac Newton. The seemingly innocent questions of Copernicus, what happens if the earth moves daily about its own axis and annually around the sun, entailed both astronomical reform and 'the birth of a new physics'. But between Copernicus and Newton falls Descartes' (and Rohault's) premature attempt to provide a substitute cosmology.

One characteristic of the scientific movement was a heightened and increasingly widespread awareness of the role of experiments in scientific investigation. In England, with Francis Bacon, Robert Boyle and the Royal Society, 'the excellent method of experimental philosophy' received perhaps its most fervent recognition. But English experimentalists had their counterparts elsewhere in Europe, in the United Provinces, Italy and France. Not that the leaders of the scientific movement saw common-sense experience as the cornerstone of their method. They recognised in nature the existence of primary and secondary qualities, that the material world was quantifiable and could be understood by reason, mathematics and 'trustworthy experiments'. The more successful among them moved along the scale of methodology, with its rationalist and positivist extremes, when it was convenient for them to do so. Rohault was not slow to try and follow their example.

Another characteristic, of importance both within and without the European scientific movement, was what came to be known as the conflict between the Ancients and Moderns. The Moderns, advocates of the new science, scholars, artisans and propagandists alike, attacked the authority of the teachings of Antiquity.

Galileo, in Italy, had to suffer the consequences of his assault on the Ptolemaic and Aristotelian descriptions of the universe. Francis Bacon, in England, in his attempt to create an empirical epistemology, aimed to cast off the strait-jacket in which, he argued, the Ancients had dressed western thought.

One characteristic of the scientific movement was a heightened and increasingly widespread awareness of the role of experiments in scientific investigation. In England, with Francis Bacon, Robert Boyle and the Royal Society, 'the excellent method of experimental philosophy' received perhaps its most fervent recognition. But English experimentalists had their counterparts elsewhere in Europe, in the United Provinces, Italy and France. Not that the leaders of the scientific movement saw common-sense experience as the cornerstone of their method. They recognised in nature the existence of primary and secondary qualities, that the material world was quantifiable and could be understood by reason, mathematics and 'trustworthy experiments'. The more successful among them moved along the scale of methodology, with its rationalist and positivist extremes, when it was convenient for them to do so. Rohault was not slow to try and follow their example.

Another characteristic, of importance both within and without the European scientific movement, was what came to be known as the conflict between the Ancients and Moderns. The Moderns, advocates of the new science, scholars, artisans and propagandists alike, attacked the authority of the teachings of Antiquity.

Galileo, in Italy, had to suffer the consequences of his assault on the Ptolemaic and Aristotelian descriptions of the universe. Francis Bacon, in England, in his attempt to create an empirical epistemology, aimed to cast off the strait-jacket in which, he argued, the Ancients had dressed western thought.

> ...men have been kept back as by a kind of enchantment from progress in the sciences by reverence for antiquity, by the authority of men accounted great in philosophy...[1] The philosophy which is now in vogue [scholastic philosophy]... tends wholly to the unfair circumscription of human power, and to a deliberate and factitious despair, which not only disturbs the auguries of hope, but also cuts the sinews and spurs of industry, and throws away the chances of experience itself.[2]

Descartes, in France, condemned the hindrances to development caused by blind adherence to the philosophies of the Ancients. Writing of "les plus passionés qui suivent maintenant Aristote", he says, "Ils sont comme le lierre, qui ne tend point à monter plus haut que les arbres qui le soutiennent, et même souvent qui redescend, après qu'il est parvenu jusques à leur faîte;".[3]

Our purpose here is not to suggest that an unbridled optimism and belief in progress or a psychological need to bolster faith in their own ability, lay at the basis of the Moderns' revolt. Nor is it our purpose to suggest that a reason for the more diluted attack by Frenchmen, as opposed to Englishmen, might lie in the nature of their Catholic and absolutist culture. It is worth emphasising, however, a few qualifications to the two-tone picture of a simple Ancient-Modern conflict.

The conflict played a more important role, in the scientific movement, at the beginning of the seventeenth century than it did at the end, when divisions, at least among the more advanced Moderns,

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[1] F. Bacon, The New Organon, ed. F.H. Anderson, New York, 1960, Aphorism LXXI, p. 69.

[2] ibid., Aph. LXXXVIII, p. 86.

[3] O.D., VI, 70.

became far more critical. Yet even in the earlier period, many realised that their ideas had been sired by Antiquity, realised that they 'could see much farther by standing on the shoulders of those who had gone before them'. Certain individuals, like Gassendi for instance, whose first published work was an attack on the followers of Aristotle, replaced one set of ideas by other ideas drawn from the Ancients. In Gassendi's case, an Epicurean philosophy replaced that of Aristotle.[4] Consciously or not, those in France, at any rate, could not help being influenced by the ideas of the Ancients, for the curricula of educational institutions were almost solely based on them. Théophraste Renaudot, for example, said respect is due to the schools as it is due to "de bonnes meres nourrices",[5] and if we should find traces of their influence in his conferences, "imputez-le à la difficulté de dépoüiller si tost cette seconde nature".[6] For minor figures principally concerned with the problems of propagating the new philosophy and with breaching the walls of the schools and universities, the division between Ancients and Moderns remained important till the end of the century and beyond.

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[4] This is a harsh judgement of Gassendi's contribution to the scientific movement. For a more balanced appraisal see chapter VI, p. 123.

[5] Première Centurie des Questions..., Paris, 1634, Preface sur les conferences, p. 1.

[6] ibid., p.2.

What emerged in writers from Campanella to Fontenelle,[7] was the desire to limit the respect for the Ancients, replace blind and unthinking esteem for their authority by reason and experiment, vindicate, in the words of Gassendi, "La Liberté philosophique".[8] Again, Rohault did not fail to join their ranks.

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[7] See, for example, B. Fontenelle, Digression sur les Anciens et les Modernes, ed. R. Shackleton, Oxford, 1955: "Rien n'arrête tant le progrès des choses, rien ne borne tant les esprits, que l'admiration excessive des anciens", p. 175.

[8] P. Gassendi, Dissertations en forme de Paradoxes contre les Aristotéliciens, trans. B. Rochot, Paris, 1959, pp. 12-13.

CHAPTER V

ARISTOTLE AND DESCARTES IN THE TRAITE DE PHYSIQUE

ARISTOTLE

It is customary to see Rohault as a scathing critic of Aristotle. He has been described as using Aristotle as "a whipping boy and a straw man"[1] and as having followed an Aristotelian classification of the sciences in his Traité because he planned "a systematic rebuttal of Peripatetic natural philosophy".[2] But his relationship with Aristotle was not simple. Compared with the vituperative attacks of some of his seventeenth century contemporaries his own treatment of Aristotle was respectful and appreciative.

Joseph Glanvill had praised Bacon for having reproved "the arbitrariness of Aristotle's words...and his affected obscurity".[3] Nicolas Poisson, in his commentary on Descartes' Méthode, wrote, "Je pourrais faire voir...qu'on ne peut lire de Philosophie [Aristotle's] qui soit tombée en tant et de si grossières erreurs".[4] Dom Antoine

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[1] by L.L. Laudan in his introduction to J. Rohault, A System of Natural Philosophy, 2 vols., Johnson reprint, New York and London, I, xv, note 9.

[2] ibid., p. xv.

[3] J. Glanvill, Scepsis Scientifica/ The Vanity of Dogmatizing, London, 1665, p. 57.

[4] [R. Descartes], Discours de la Méthode...Contenant la Méthode et la Méchanique..., Nouvelle édition augmentée des remarques du P. Poisson Prêtre de l'Oratoire, 2 vols., Paris, 1724, I, 348.

Vinot claimed that "Aristote a corrompu toute la véritable physique".[5] Rohault, on the other hand, owed to Aristotle his "premières lumières".[6] In his Traité he expressed his belief that the passage of time brought unlimited scientific progress. He showed where he agreed with Aristotle, where he thought Aristotle was limited and where he built on Aristotle's work. In effect this amounted to a demonstration of the superiority of Descartes' system but what is remarkable is the deferential way in which he chose to express this superiority. Aristotle was introduced as having supplied the 'general notions' of his physics. It was Aristotle's followers who were unworthy of their master since they misrepresented his thought and hindered progress. Rohault did not insist that the cartesian system demolished and replaced Aristotle's but hinted that one was the progressive extension of the other.

In the preface to his Traité Rohault says he has taken from Aristotle the 'general notions' of his physics, belief in a plenum, the divisibility of matter and the necessity of considering the quantity and motion 'of the insensible parts of which sensible things are composed'.

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[5] Chartres, 366, Vinot à Clerselier, 1660. "C'est bien plus court de dire avec le grand Chancelier Bacon, qu'Aristote a corrompu toute la veritable physique des anciens par l'effusion qu'il a faite de sa metaphysique sur la Physique et qu'il l'a tirée hors du sensible et du solide par ses abstractions chimeriques et par ces façons de parler obscures et embrouillées que Tertulien appelle excellement minutiloquium aristotelis."

[6] Rohault, Traité, Paris, 1671, preface, not pag.

> J'ay pris d'Aristote toutes les notions generales, soit pour l'établissement des principes des choses naturelles, soit aussi pour ce qui regarde leurs principales proprietez. Et me contentant de rejetter le Vuide, et les Atomes, ou Insecables d'Epicure, qui estoient des choses contraires à ce que je croyois solidement étably par Aristote, j'ay appris de luy à considerer, avec le plus de soin qu'il m'a esté possible, les differentes grosseurs, les figures, et les mouvemens des parties insensibles, dont les Estres sensibles sont composez. Ce que j'ay fait d'autant plus volontiers que toutes ces choses ont une liaison et une relation necessaire avec la divisibilité de la matiere, que je reconnois avec Aristote, qui ne resout luy mesme gueres de questions particulieres, qu'il ne fasse considerer la grosseur, la figure, et le mouvement des parties des corps, et les pores qui sont entr'elles...[7]

Admittedly these may be described as Descartes' 'general notions' rather than Aristotle's but Rohault gave the credit to Aristotle.

In the text of the Traité, especially of Part one, Rohault seriously examines Aristotle's ideas on almost every topic he treats, giving approbation where he thinks it is due. His favourable references to Aristotle are made in particular instances and on a general plane: "we may say with Aristotle, that all Sensation is a kind of passion";[8] we may retain the use of the word 'quality' "...car ce mot est ce me semble fort commode (ainsi qu'il a autrefois aussi semblé à Aristote)";[9] to understand what matter is we must distinguish its essence, properties and accidents.[10] As well as the

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[7] loc. cit.

[8] Rohault, System, I, 2, 16.

[9] Rohault, Traité, I, 4, 25.

[10] ibid., I, 7, 35.

Aristotelian inspiration of his terminology there are suggestions of parallels between his method and that of Aristotle: a brief historical treatment at the beginning of each subject, use of the syllogism, deduction from universals to particulars; in addition, the last chapter of Part one is displayed in the form of Aristotle's Problems.[11] But the most remarkable concession which Rohault made, was his presentation of the two principles of natural things as matter and form.[12] He distinguishes between Aristotle the metaphysicist and Aristotle the physicist and maintains that his idea of matter as extension is not contrary to Aristotle's idea of matter even though some of Aristotle's disciples say that it is. His own idea of matter is "indépendante de tout Estre crée".[13] When Aristotle speaks of matter in general and distinguishes between extension and quantity, "il n'y a aucune repugnance que la matiere soit une substance estendue et que cependant elle ne soit rien de tout ce qu'on peut respondre aux questions dont Aristote fait le dénombrement".[14] Like Aristotle he believes in the divisibility of matter and since every division of matter presupposes movement he agrees with Aristotle that "we must understand what "movement" is;

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[11] ibid., I, 35.

[12] ibid., I, 6.

[13] ibid., I, 7, 38.

[14] ibid., I, 7, 39.

for if we do not know this, neither do we understand what Nature is".[15] The necessary consequence of the divisibility of matter is local motion (change of place) and has as its effects accretion, diminution and alteration.[16] As to form, it is possible, writes Rohault, that Aristotle acknowledged essential forms rather than substantial forms, as he does, since the Greek word Aristotle used "may as well or better signify the one than the other".[17] Forms he divides into two categories, "des Estres Simples", like the elements, and "des Estres composées", which are capable of a great many properties.[18]

His belief in the progress of the arts and sciences limited, of course, his estimation of the value of Aristotle's ideas and was the means by which he presented the more detailed and hence more advanced cartesian system. He agreed with Desgabets that Aristotle had written "...de fort beaux discours generaux et metaphysiques touchant les choses naturelles"[19] and agreed that it was idle and totally inadequate for someone in the seventeenth century to remain at this level of

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[15] Aristotle, <u>The Physics</u>, trans. P.H. Wicksteed and F.M. Cornford, 2 vols., London and Cambridge, Mass., 1952 and 1957, I, Book III, chapter 1, p. 191. See Rohault, <u>Traité</u>, I, 9, 55.

[16] Rohault, <u>Traité</u>, I, 17.

[17] Rohault, <u>System</u>, I, 18, 104.

[18] Rohault, <u>Traité</u>, I, 18, 130-1.

[19] Chartres, 366, Reflexions pour la Justification de l'Escrit 'Ad Hominem' contre messieurs de Port Royal Intitulé considerations sur l'estat present de la Controverse touchant le St. Sacrement de l'autel.

generality. There is, in his Traité, he says, "un tres-grand nombre de choses dont Aristote ny ses Disciples n'ont pas coûtume de traiter".[20] He explicitly points to the inadequacy of Aristotle's opinions on heat and cold, taste, light and colour. Aristotle has only said what heat and cold do, not what they are.[21] He has not defined the property of a body which causes taste "nor wherein it consists".[22] His explanation of light and colour is unsatisfactory because

> ...we are still at a loss to find out more particularly what the Nature of transparent Bodies, and also what the Nature of luminous Bodies is, and further how the Presence of the Latter operates on the other, to bring its Power into Act, and last of all, what that is which moves a Body that is actually transparent.[23]

These criticisms served as a prologue to his own, cartesian explanation of these questions.

Like Pierre Gassendi,[24] Rohault scorned the disciples of Aristotle rather than Aristotle himself. They were the corrupters of Aristotle's doctrines who had "partagé toutes les écoles sur le sens d'une infinité de textes"[25] and whose excessive veneration of their master

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[20]Rohault, Traité, preface, not pag.

[21]Rohault, System, I, 23, 152.

[22]ibid., I, 24, 170.

[23]ibid., I, 27, 199.

[24]Gassendi, Dissertations, p. 12. Gassendi scorns Aristotelians for amassing "des questions sur des broutilles et des balivernes qui ne pouvaient venir à la pensée d'Aristote".

[25]Rohault, Traité, preface, not pag.

had hindered the progress of physics. Rohault rejects their opinion on hardness, liquidity, taste, smell, light and colour as perpetuating the error of considering sensations as qualities belonging to objects themselves. He is particularly censorious of their attempt to clarify Aristotle's doctrine of vision by means of 'intentional species'.[26] Aristotle, in Book two, chapters seven and twelve, of his De Anima, states that an "Object must act upon" a transparent "medium in order to have its Action transmitted to the Organ of Sight"[27] and "that in every Sensation we receive the Images [the perceptible form] of the Things, but not the Matter...".[28] Aristotelians, taking the word 'image' literally, argue that an object impresses a series of images on the air around it and that one of these images is impressed on the crystalline humour of the perceiver's eye. Rohault rejects this idea as absurd. The analogy which Aristotelians make of mercury behind a mirror and the vitreous humour of the eye is a false one since the vitreous humour is transparent, not opaque. There is a crystalline humour in each eye. If we looked at an object with both our eyes two 'species' would be formed by the object at the same time and we should see it double. Once the image of an object six feet high and ten yards away came within five yards of our eye

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[26] Rohault, System, I, 29.

[27] ibid., I, 29, 236.

[28] loc. cit.

we would see only a small part of it. Nor can Aristotelians evade this last criticism by pretending that the intentional species adapt themselves to act upon eyes which are close and eyes which are distant for this would endow inanimate objects with human understanding. Their doctrine is contrary to reason and experience. It is absurd. "It is a mere sophism...".[29] It "has...put their Understandings upon the Rack".[30]

Rohault admitted that there were certain parts of his treatise where he contradicted Aristotle but believed that they were relatively few: "...venant à comparer les endroits où je me trouve contraire à Aristote, avec les écrits de ceux qui professent publiquement sa Philosophie, je n'en ay pas trouvé a beaucoup prés un si grand nombre dans mon ouvrage, que dans ceux des autres".[31] He explicitly rejects privation[32] as a principle of natural things, the four elemental substances (earth, water, air and fire),[33] Aristotle's dictum that everything in motion tends to rest,[34] his belief that sound is the "motion of a body that is hard, polished and concave"[35]

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[29] ibid., I, 29, 237.

[30] loc. cit.

[31] Rohault, Traité, preface, not pag.

[32] Rohault, System, I, 6, 22.

[33] ibid., I, 19, 107.

[34] ibid., I, 11, 47.

[35] ibid., I, 26, 185.

and his opinion on comets,[36] gravity and levity.[37] It is almost as if Rohault blinded himself to the implications of the cartesian system basic to his treatise. What is certain is that he chose not to emphasize explicitly that his cartesian system undermined that of Aristotle.

Rohault's cartesian principles were not in agreement with those of Aristotle; either his concept of matter, his laws of motion or his definition of the elements. His attempt to fuse Aristotelian 'matter' and cartesian 'matter' was ill-starred and strained. While Aristotle admitted that extension and impenetrability were primary attributes of matter, he did not admit that they were its essence: "By matter I mean that which in itself is neither a particular thing nor of a certain quantity nor assigned to any other of the categories by which being is determined...".[38] Contrary to what he said, Rohault's identification of matter and extension might be interpreted loosely as Aristotle's matter actualized in matter-form. But this isolates only one aspect of Aristotle's doctrine of matter and form. It does not, as Rohault did not, take full account of

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[36] ibid., II, 26, 83.

[37] ibid., II, 28, 93.

[38] Aristotle, The Metaphysics, trans. H. Tredennick, 2 vols., London and Cambridge, Mass., 1947, I, Bk. VII, ch. 3, pp. 317-19.

Aristotle's doctrine of potentiality.[39] Neither his laws of motion nor those of Descartes, particularly the concept of rectilinear inertia, accorded with Aristotle's upward-downward motion of the four elements of the sublunary region[40] or his constant, circular motion of the immutable caelestial region.[41] If we glance at the Aristotelian and cartesian world-picture, both of which can be drawn from the various chapters of Rohault's Traité, we can point to fundamental differences. Rohault's heliocentric-vortex system was not Aristotle's geocentric system of nesting, concentric spheres.[42]

And yet, Rohault's Traité implicitly demonstrated the superiority of Descartes' natural philosophy. His problem was to reconcile Descartes and Aristotle and at the same time show the superiority of Descartes, a problem which he solved by firing four shots across the bows of his critics: he stressed that his 'general notions' agreed with Aristotle; he continually differentiated between Aristotle and his disciples and attacked the latter; he argued that his opinions built on and improved the doctrines of Aristotle; and finally, he appears to have avoided emphasizing the implications of what he was saying.

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[39] See Aristotle, Metaphysics, I, III, VI, 145; VII, XVI, 391; IX, VII, 451 ff. See also, Aristotle, The Physics, trans. P. Wicksteed and F.M. Cornford, I, I, VII, 71-83.

[40] See Aristotle, Physics, VIII, IV, 313-7, and Aristotle, On the Heavens, trans. W.K.C. Guthrie, London and Cambridge, Mass., 1953, I, II, 15.

[41] Aristotle, Physics, VIII, VIII, 395, and Aristotle, On the Heavens, I, II, 15-17.

[42] Aristotle, On the Heavens, II, IV,155 ff; II, XII, pp. 203-13; II, XIII, 217 ff.

The interesting question which arises, from the point of view of understanding Rohault's personality and the difficulties of French cartesians, is what motivated Rohault to pay so much deference to Aristotle. Did he wish to pose as an objective critic of Aristotle or does his attempted reconciliation stem from his mediocrity? Was he more inclined to give a favourable evaluation of Aristotle's work because he was unable to break away from his university education or because he felt there was a philosophic affinity between the systems of Aristotle and Descartes? Can we find the key to his conciliatory tone in the politico-ecclesiastical persecution which French cartesians faced especially during the period 1663 to 1678?

The influence of university education on the scientific movement of the sixteenth and seventeenth centuries has tended to be understated. Many leading figures of the movement had intimate relations with universities. Vesalius studied at Louvain and Paris and taught at Padua. Galileo studied at Padua and taught at Pisa. Newton studied and taught at Cambridge. And even if the influence of traditional education was negative in the sense that many revolted against it and even if much of the progress that was made in the sciences was made in spite of, rather than because of, university curricula, it was not easy for graduates to cast off completely, as Renaudot says, "cette seconde nature" acquired from the schools. Claude Clerselier edited Descartes' letters in the curricular format of a three year university philosophy course. Volume one dealt with logic and ethics, volume two with physics and metaphysics, volume three with mathematics.

René Fedé, too, had been trained in the rigid discipline of the schools: "...nous sommes donc obligez de dire qu'elle [la matière] est indefinie, ce qui dit negation de conception dit finy et de l'infiny".[43] Rohault had followed the Aristotelian based courses at Paris university and as we see from his Traité he retained an affection for his early master.

Undoubtedly, the further we look the more hypotheses we can discover to account for Rohault's tolerant attitude towards Aristotle. He recognized the value of Aristotle's work. He saw that Aristotle and Descartes had a comprehensive 'system' for the interpretation of nature. He was encouraged by his belief in progress. As a propagandist he desired to win acceptance for Descartes' doctrines in schools and universities and hence made his innovations palatable to his most formidable opponents. It is our contention, however, upheld in detail in Chapter X, that the best hypothesis is that which ascribes most influence to the threat of persecution which French cartesians faced between 1663 and 1671, partly as a result of their own endeavours to promote Descartes' doctrine of the eucharist.

DESCARTES

The Traité de Physique was thoroughly cartesian. We have noted in Chapter IV that Rohault borrowed heavily from Descartes' works, particularly the Discours and Principes. No doubt, like many others,

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[43] Ste. Geneviève, 2225, fols. 11vo - 12ro.

he was fascinated and attracted by the universality of Descartes' philosophy, especially the physical system constructed on such a small number of supposedly self-evident truths. In the preface to his Traité he acknowledged his debt to Descartes and explained why his name did not recur throughout the text:

> celuy qui a le plus contribué à la composition de cet Ouvrage, duquel cependant le nom ne se trouvera nulle part, parce qu'il l'eust falu trop souvent repeter, est le celebre Monsieur Descartes.[44]

Rohault has been described as 'a precursor of modern experimental physics',[45] "le premier physicien moderne"[46] who, in his Traité de Physique tended "to separate Descartes' physics from his metaphysics"[47] by defining "an entirely positivist mathematical physics"[48] which replaced Descartes' system of the world by an encyclopaedic, experimental "...atlas d'images mécaniques".[49] In order to examine these opinions as well as the nature of Rohault's adherence to the cartesian system we ought to consider whether Rohault completely rejected or only condensed the metaphysical basis to cartesian physics and whether or not he buried Descartes' system in his encyclopaedic-particularist approach.

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[44] Rohault, Traité, preface, not pag.

[45] A. Gautier, op. cit.

[46] A. Saverien, Histoire des Philosophes Modernes, VI, p. xxix.

[47] W. Doney, "Cartesianism", Encyclopaedia of Philosophy, ed. P. Edwards, 8 vols., New York and London, 1967, 2, 39.

[48] P. Mouy, La Physique Cartésienne, p. 114.

[49] ibid., p. 117.

In the Traité the amount of space devoted to metaphysics is very small, compared with that in Descartes' Principes and Méditations. Compared with that of cartesians of his generation such as La Forge, Cordemoy, Clerselier and Desgabets, Rohault's interest in metaphysics is lukewarm. The contribution of La Forge and Cordemoy to the development of occasionalism and the singular devotion of Clerselier and Desgabets to Descartes' interpretation of the eucharist are without parallel in Rohault's Traité. Contrast, for example, Desgabets' description of the extent of his estimation and ambitions for cartesian philosophy with Rohault's defence of his Traité in his Entretiens sur la Philosophie. In a letter of February 1671 Desgabets wrote:

> J'ay tasché pendant ces dernières années de découvrir dans les plus belles opinions de Mr Descartes des usages fort Inconnus, les faisant servir a la decouverte des plus grandes veritez telles que sont celles qui appartiennent au mystere de la Ste. Trinité, la transfusion du peché original, des systemes de St. Augustin et de St. Thomas touchant la predestination et la grace, des principaux attributs de Dieu, des choses possibles.[50]

Rohault defended his Traité by arguing that the philosopher should concern himself with philosophy, the physicist with physics and the theologian with theology: "...j'ay seulement traité des choses comme elles sont en leur estat ordinaire et naturel...".[51] Desgabets was primarily a priest-cartesian, Rohault a cartesian physicist.

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[50]Chartres 366, Desgabets à Clerselier, Février 1671.

[51]Rohault, Entretiens, p. 10, and B.N. 14837 fol. 239.

We should be wary of imposing, however, an ambiguous 'modernity' on Rohault. Plenty of evidence exists to show that there was no question of a complete rejection of metaphysics in his life and work. His Lettre à Guyard and Entretiens sur la Philosophie attempted to explain Descartes' opinion on transubstantiation and the beast-machine, albeit from the point of view of a physicist. Rohault had a personal interest in entering the beast-machine and eucharist controversies. He was attempting to stave off censorship of his Traité. As a sincere Catholic he was interested in these problems for their own sake. Living as he was in a society where teaching was in the hands of clerics and where man's relationship with God and the Church was the most important aspect of his life it was natural to look at the theological implications of cartesian philosophy. At any rate he was encouraged in this direction by his close friend and father-in-law, Claude Clerselier. Furthermore, memory of the fate of Regius, whose Fundamenta Physices[52] had incurred the wrath of Descartes, was too much alive[53] for Rohault to have forsaken the metaphysical foundations of cartesian physics.

René Fedé's summary of Rohault's conferences of 1660 and 1661 show that Rohault gave a course of demonstrated lectures on physics beginning with what he thought was the necessary metaphysical foundation.

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[52] H. Regius, Fundamenta Physices, Amsterdam, 1646.

[53] see O.D., V, 625-7.

TABLE II [54]

Date of Conference	Subject
Novembre 1660	Knowledge
Decembre 1660	Existence and certitude: essence of matter
Dec. 15 1660	Matter and its nature
Dec. 22 1660	Experiments on the possibility of a vacuum
Janvier 1661	Properties of matter: motion and rest
Mercredy 1661	Examination of the Senses: Matter under touch: hardness and liquidity
Fevrier 9 1661	Heat and cold
Mars 9	Matter under taste
Mars 23	Light
Mars 30	Colour
Avril 6 et 27	Vision
Nov. 1669 (?)	The ebb and flow of the tide
17 Nov. 1660	The lodestone
——	Comets

Fedé's account of Rohault's metaphysical preliminaries is similar to the early chapters of part one of the <u>Traité</u> - with a few exceptions. In conference and <u>Traité</u> Rohault used the cartesian method of doubt, cogito, real distinction between mind and body and God's guarantee of our knowledge of the external world.

[54] From Bib. S[te.] Geneviève, 2225.

In Fedé's record Rohault states that we recognize the existence of ourselves and of the external world by a combination of sensation and reasoning. We become certain of our own existence because innate reason, coming from "je ne sçay quel amour de nous mesmes qui nous persuade aisement que nous ne nous trompons pas",[55] teaches "...qu'il repugne a la bonte de Dieu de nous avoir créez pour une erreur continuelle".[56] God has willed (bien voulu) that we have knowledge of our existence and of His existence since He has given us the means to draw the 'cogito' from doubt and since "Il nous a encore donné les moiens de conclure qu'il est, parce que nous ne pouvons pas avoir esté avant que d'estre et qu'ainsy ne nous estant pas engendré nous mesmes nous sommes obligez de remonter a nostre origine".[57] Beyond these two certainties, however, there is only probability (au dela de ces deux premieres [connoissances] nous ne trouvons plus que de la probabilité).[58] Nonetheless what makes us believe in the existence of the external world is that we experience "diverses sensations en diverses sens en un mesme temps"[59] and "diverses sensations en un mesme sens en divers temps".[60] We have further knowledge of "des Estres hors de nous", we can conceive of

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[55]ibid., fol. 5^{vo}.

[56]ibid., fol. 6^{ro}.

[57]loc.cit.

[58]ibid., fol. 6^{ro}- 6^{vo}.

[59]ibid., fol. 7^{ro}.

[60]loc.cit.

substances and accidents because our innate reason, experience and reflection distinguish between the substance wax and the accident roundness. Gunpowder which was once "noire, pesante, froide, peu estendue"[61] becomes "lumineuse, legere, bruslante et d'une extreme estendue"[62] but for all the accidental change "ne laisse pas de subsister apres comme devante".[63] ("la poudre à canon n'est pas perie puisque c'est de nostre commune connoissance que quelques choses ne sçauront devenir rien").[64] Similarly, 'This flame is not born of a pure privation' for nothing is made from nothing, "...c'est donc une matiere mesme, qui dans ces deux facons d'estre opposez, subsiste tousiours".[65]

In the Traité Rohault follows the more orthodox procedure of starting from a position of doubt, establishing the knowledge of our thinking self via the cogito, thereby drawing a distinction between mind and body, before moving on to show that we have knowledge of the existence of material things by use of 'the several means of knowing that are in us'. Further knowledge of material things starts from his statement of general self-evident truths. Reasoning on these and on the effects of his experience he 'establishes' the principles of natural things as matter and form.

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[61] ibid., fol. 7^{vo}.

[62] loc. cit.

[63] ibid., fol. 8^{ro}.

[64] loc. cit.

[65] loc. cit.

If the Traité is compared with Descartes' Principes alone it is noticeable that Rohault gives only a condensed description and explanation of Descartes' metaphysics. Particularly noticeable is the fact that in establishing the existence of beings other than his thinking self Rohault fails to emphasize the transcendental route taken by Descartes. He absolves himself by stating baldly that reason can assure us of God's existence and by acknowledging God as the author of every thing in the world.[66] His argument is that his design is "to consider Things in their ordinary and natural State... not to say, or determine, what they are, or may be, in an extraordinary or preternatural state".[67] He therefore not only condensed cartesian metaphysics but tactfully or timidly thought it wiser to leave transcendental philosophy to theologians. Despite these qualifications, it is worth repeating that, at the beginning of the Traité, there is a metaphysics traced which is cartesian in inspiration.

Rohault accepted Descartes' invitation in the preface to the Principes to undertake a detailed "recherche de ces veritez"[68] that could be deduced from his principles. His principal contribution to the scientific movement of the seventeenth century was to write a textbook which synthesized and attempted to empirically justify Descartes' physical system. His attempt was successful in the sense that his Traité used the techniques of artisans, experiments performed

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[66] Rohault, System, I, 2, 5 and I, 6, 20.

[67] ibid., I, 6, 20.

[68] O.D., IX-2, nouvelle présentation, Paris, 1964, preface, p. 20.

by himself, by Galileo, Huygens, Pascal, Harvey, Pecquet and Cassini to illustrate and extend Descartes' physical theories.[69] And consequently he submerged Descartes' physical system with his particularist approach and exposition. Nonetheless, Descartes' system remained, buried, sometimes condensed, simplified and even incomplete in parts, but still fundamental to the treatise. The characteristics by which we recognize Descartes' mechanistic physical system are found in Rohault's Traité: matter and motion as the source of explanation, imaginative use of subtle-matter, and the theory of vortices.

As we have remarked in Chapter IV, Rohault identified space with matter, matter extended in length, breadth and depth, impenetrable and capable of being divided indefinitely.[70] Motion was described as local motion, the transport of a body from 'the different parts of those bodies which surround it'.[71] The three elements were formed supposedly as a consequence of the division of primary matter into an infinite number of nearly equal parts and on the supposition that God made these parts turn in many different ways about their several centres.[72] Particles of matter were thus regarded as geometric solids occupying all the various parts of space and subject to change because of the impact and pressure of their neighbours.

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[69]see Chapter VI.

[70]see Chapter IV, p. 60

[71]see Chapter IV, p. 61

[72]Rohault, System, I, 21, 115.

Rohault's laws of motion were eseentially Descartes' laws, incompletely modified but clearly and simply expressed. He retained the cartesian concepts of inertia, of rectilinear motion and of the conservation of momentum. Descartes' first two laws were repeated by Rohault almost verbatim.

	ROHAULT	DESCARTES
(1)	...lés choses doivent toûjours demeurer dans un mesme estat, si ce n'est que quelque chose exterieur le change ... ce que a commencé à se mouvoir ne peut jamais de soy cesser de se mouvoir.[73]	chaque chose en particulier... continuë d'estre en mesme autant qu'il peut, et que jamais elle ne change que par la rencontre des autres...si un corps a commencé une fois de se mouvoir, nous devons conclure qu'il continuë par apres de se mouvoir, et que jamais il ne s'areste de soy-mesme.[74]
(2)	Un corps...doit toûjours décrire une ligne droite puisque c'est la seule détermination qui soit naturelle à un corps qui se meut.[75]	...chaque partie de la matiere, en son particulier, ne tend jamais à continuer de se mouvoir suivant des lignes courbes, mais suivant des lignes droites...[76]

Rohault's laws of the conservation and communication of motion and laws of impact, even if incomplete, were described in his customary lucid fashion.

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[73] Rohault, Traité, I, 11, 63.

[74] O.D., IX-2, nouv. prés., Part II, article 37, p. 84.

[75] Rohault, Traité, I, 13, 101.

[76] O.D., IX-2, nouv. prés., II, 39, 85-6.

(1) Un corps qui se meut perd autant de son mouvement qu'il en communique.[77]

(2) Un corps qui se meut perd moins de son mouvement à la rencontre d'un corps qui en a déja qu'à la rencontre d'un corps qui est en repos.[78]

(3) ...les plus gros corps continuent plus longtemps à se mouvoir que les plus petits.[79]

(4) ...un corps qui se meut directement fait que d'autres se destournent en anneau pour prendre sa place.[80]

(5) ...les corps qui se meuvent en rond tendent à s'éloigner du centre du cercle qu'ils décrivent, et qu'ils disposent les autres à s'en rapprocher.[81]

(6) ...un corps qui en se mouvant en rencontre un autre qu'il ne peut ébranler, se doit refléchir...et...il continuera de se mouvoir avec la mesme vitesse qu'il faisoit auparavant.[82]

(7) ...il n'y a point de moment de repos au point de reflexion.[83]

(8) ...un corps qui tombant perpendiculairement, se doit reflechir perpendiculairement.[84]

He did not repeat Descartes' seven secondary rules of impact, the weaknesses of which were well known. (In 1647, for example, Clerselier showed the falsity of the fourth of these rules by citing the instance of a cannon-ball being set in motion by the bullet from a pistol.) And he did not develop his laws of motion as he might have done. He

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77 Rohault, Traité, I, 11, 65.

78 ibid., I, 11, 66.

79 ibid., I, 11, 67.

80 ibid., I, 11, 69.

81 ibid., I, 13, 102.

82 ibid., I, 13, 103.

83 loc. cit.

84 ibid., I, 13, 104.

failed to examine, for example, the question suggested by the first of Descartes' secondary rules: what happens "...si...deux corps... estoient exactement égaux, et se mouvoient d'égal vitesse en ligne droite l'un vers l'autre...".[85] His neglect is even more surprising since Huygens had published his "Propositions touchant le mouvement de percussion" setting out his laws of elastic and non-elastic collision in the Journal des Sçavants of March 1669.

Rohault had inherited the weaknesses of Descartes' geometric approach. As Samuel Clarke noted, he did not see that "...Motion may be destroyed, and hard Bodies that have no Elastick Force, when they strike against each other, are not reflected, but lose their Motion",[86] that "...there may be a Moment of Rest, in the point of Reflexion; because the reflected Motion is not a continuation of the Direct; but a new Motion impressed by a new Force, viz. the Force of Elasticity".[87] Force was ambiguously reckoned as the effort or action produced by the speed, number, size and disposition of particles of matter. Mass was equated with size, bulk or volume. Weight was not an explanatory principle but something which required explanation. It was a centripetal reaction in a vortex of bodies of a certain size. Indeed a cartesian concept of matter and motion remained the basis of Rohault's explanation of natural phenomena.

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[85] O.D., IX-2, nouv. prés., II, 46, 89.

[86] Rohault, System, I, 11, 48, note 1.

[87] ibid., I, 13, 81, note 1.

Following his kinetic theories of matter and motion and despite his desire to give a detailed and precise explanation of the workings of nature, Rohault made widespread, even excessive, use of a general and loosely defined theory of subtle-matter. New Presbyter was old priest writ large. Descartes' and Rohault's use of this theory made their physics as qualitative as Aristotle's had been. Rohault maintained the existence of subtle-matter was proven by reason and experience. Without it "il n'arriveroit rien de tout ce que nous avons remarqué qui arrivoit, en expliquant les mouvemens qu'on avoit coûtume d'imputer à la crainte du vuide".[88] The shape, size and motion of subtle-matter were crucially important in explaining, for example, the 'power of springing',[89] the nature of the stars,[90] why the earth's axis "garde toûjours une espece de Parallelisme, pendant son transport annuel autour de Soleil",[91] and the properties of the magnet. Iron, Rohault argues, is not attracted to the magnet or a magnet to iron but is impelled by "a third Body, or rather a certain Matter which is in Motion, and which is very subtle, because it cannot be perceived by our Senses".[92]

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[88] Rohault, Traité, I, 27, 272.

[89] Rohault, System, I, 22, 133-4.

[90] ibid., II, 25.

[91] Rohault, Traité, II, 25, 99-100.

[92] Rohault, System, III, 8, 167.

Descartes' vortex theory was the wider theory which included his theory of subtle-matter. It was an essential ingredient in Rohault's physics, notably in his explanation of 'gravity',[93] the ebb and flow of the tide,[94] the properties of the magnet, sun spots[94] and the motion of the planets. Rohault's world picture was simpler than that of Descartes. Instead of giving a detailed analysis and explanation of Descartes' planetary system he showed how the Copernican hypothesis best accounted for the appearances of sun, fixed stars and planets. But he supported this model with Descartes' theory of vortices scattered throughout part two of his Traité. The sun, like the other stars, he declared, is composed for the most part of the first element and is situated very near the centre of "a certain vortex...which reaches every way a great deal beyond Saturn".[95] This vortex of matter of the first and second element carries the planets, composed mainly of the third element, around the sun. Inside it there are other small vortices such as those surrounding Jupiter[96] and the Earth.[97]

Descartes' vortex theory, however, appeared only in an abbreviated form. Rohault made full use of it in his explanation of terrestial

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[93] ibid., II, 28.

[94] ibid., II, 29.

[95] ibid., II, 25, 60.

[96] ibid., II, 16, 45.

[97] ibid., II, 22, 56; III, 1, 123; III, 1, 125.

phenomena. (Heavy bodies fall because they are pushed violently by subtle matter receding from the centre of the earth's vortex.)[98] But he did not attempt to defend the wider aspects of the theory. He did not elaborate, for example, on its use as a physical explanation of planetary motion and distribution except to repeat Descartes' attempt to reconcile his system with the Bible by maintaining that the Earth did not move.

> ...if it be rightly understood that Motion <u>is nothing else but the successive Application of the Superficies of any Body, to the different Parts of the Bodies which surround it, and immediately touch it</u>, we shall see, that what we call the diurnal Motion of the Earth, belongs rather to the whole Mass composed of Earth, Seas and Air, than to the Earth in particular; which ought to be looked upon as at perfect rest, so long as it is carried by the Torrent of Matter in which it swims; in the same manner as we say, that a Man who is asleep in a Ship, is at rest, though the Ship really is in Motion. So likewise will it appear, that the Motion which we commonly call the annual Motion of the Earth, does not at all belong to it, but to the Caelestial Matter, which carries this whole Mass about the Sun.[99]

Without too much distortion, then, it can be asserted that Rohault's model of the world was a Copernican one supported by cartesian physics.

In writing his <u>Traité de Physique</u> Rohault was strongly influenced by two dominant characteristics of seventeenth century science: the search for an acceptable cosmological system and the desire to proceed by an experimental method. The dilemma in which he found himself

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[98] ibid., II, 28, 93-4.

[99] ibid., II, 24, 62.

was whether to uphold the new philosophy and thus provoke the opposition of the 'Ancients' or to try and produce a reconciliatory synthesis and thus alienate the more outspoken of the 'Moderns'. He chose to demonstrate, not always with success, that the cartesian system which he had adopted was reconciliable with the basic ideas of Aristotle's physics. He proposed that the general notions of his physics agreed with those of Aristotle but failed to emphasize where they disagreed and where he could be said to have demolished the Aristotelian system. At the same time, he stressed the superiority of Descartes' system and in doing so banished from his physics final causes, substantial forms, rational entities, intentional species, attraction and 'the prejudice of ascribing sensations to objects'.

Another problem, which he faced, arose from the defects inherent in Descartes' physics. For the most part Rohault's weaknesses were Descartes' weaknesses but he found it necessary to abbreviate, revise and occasionally neglect certain aspects of Descartes' work, notably the ontological proof of God's existence, certain laws of motion and parts of the vortex theory. And finally, in an attempt to keep abreast of current developments in the scientific world he dressed his physics in an empirical garb. We shall now turn to look more closely at the sources of Rohault's 'empiricism'.

CHAPTER VI

EXPERIMENT IN THE TRAITE DE PHYSIQUE

The scientific method of French scientists in the mid-seventeenth century was similar to that practised elsewhere in Europe. The book-learning of the schools was held in disdain. There was recognition of the need for more experiments and for a logical, quantitative approach to scientific studies. There existed the prerequisites and means of propagation needed for the spread of scientific knowledge and for knowledge of scientific method: mathematical tools, comparatively sophisticated instruments, organs of communication and the interest necessary to stimulate particular problems. Knowledge of particular problems advanced by a complementary process of conceptualization and experiment. Rohault, for example, maintained,

> ...pour proceder juste dans la recherche des choses naturelles, il faut necessairement allier ces deux moyens de connoissance, et joindre ensemble le raisonnement avec l'experience.[1]

This chapter argues that Rohault's love of experimentation depended not only on his own experimental dexterity but also on Descartes' influence and the current trend of French, natural philosophy. It would be an arduous task to trace the origins and development of seventeenth century European empiricism. Let us confine ourselves to the French situation, the situation of Jacques Rohault. We shall

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[1] Rohault, Traité, preface, not pag.

define empiricism not as the doctrine which regards experience as the only source of knowledge but as the belief that experiments are one of the most important sources. Contrary to Henry Oldenburg's opinion that French natural philosophers were too airy and "discursive yn active and experimentall",[2] we maintain that there was an empirical tradition in the sciences in mid-seventeenth century France. Frenchmen interested in natural philosophy both influenced and were influenced by experiments performed elsewhere in Europe. Men like Fabry de Peiresc,[3] Mersenne,[4] Bouilliau,[5] Chapelain,[6] Sorbière[7] and Henri Justel[8] exchanged information, including information of experiments performed and experiments made, with scholars in England, Italy, the United Provinces, Germany, Denmark and Sweden. Letters, books, broadsheets, pamphlets and extracts passed between scholars, secretaries of academies and editors of Journals.

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[2] The Correspondence of Henry Oldenburg, ed. and trans. A.R. and M.B. Hall, Oldenburg to Boyle, 23 July 1659/2 August 1659(N.S.), I, 287.

[3] see Lettres de Peiresc, ed. T. de Larroque, 8 vols., Paris, 1888-98.

[4] see Correspondance du P. Marin Mersenne, pub. Mme. P. Tannery, C. de Waard avec la collaboration de R. Pintard, 8 vols., Paris and Dijon, 1932-64.

[5] see B.N. Fonds Français 13041; 13027; Fonds Dupuy 18.

[6] see Lettres de Jean Chapelain, ed. T. de Larroque, 2 vols., Paris, 1880-3.

[7] see Relations, lettres et discours de M. de Sorbière sur diverses matières curieuses, Paris, 1660; Sorberiana ou Bons Mots, rencontres agréables, pensées judicieuses et observations curieuses de M. de Sorbière, Paris, 1694; B.N. Fonds Latin 10352.

[8] see B.N. F. Fr. 15189, Correspondance de Huet, fols. 141vo et seq.

Among Frenchmen, Marin Mersenne publicized the work of Galileo and the problems it raised. In 1634 he published *Les Méchaniques de Galilée*[9] and in 1639, *Les Nouvelles Pensées de Galilée*.[10] He, himself, showed particular interest in experiments on acoustics and in experimental tests for the law of free fall (la chute des graves). Question V of his *Questions inouyes*, for example, reads "Quels corps sont plus aisez à faire mouvoir ou rouller sur la terre ou sur un plan?".[11] In his *Harmonie Universelle* he gave an account of his experiments on vibrating chords, on the relation between the density of the vibrating chord and the pitch of the sound, on the tubes of the organ, their resonance, and the relation between their tonality and their weight, their size and their density.[12]

The 'new philosophy' of Francis Bacon first met with qualified success among French scholars. A critical Mersenne thought "le dessein de Verulamius est impossible"[13] but at least said, if naively,

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[9] M. Mersenne, *Les Méchaniques de Galilée*, Paris, 1634.

[10] M. Mersenne, *Les Nouvelles Pensées de Galilée*, Paris, 1639.

[11] M. Mersenne, *Questions inouyes ou Recreation des Scavans...*, p. 15. Cited in *Correspondance du P. Marin Mersenne*, III, 303. See also the *Nouvelles Pensées*, p. 69.

[12] M. Mersenne, *Harmonie Universelle*, 2 vols., Paris, 1636-7. See "Deo Instrumens", I, V, 255, 201(misprint), 331-46, and in Tome II the "Nouvelles Observations Physiques et Mathematiques" and "Traitez de la nature des sons, et des mouvemens de toutes sortes de corps". In the 'Preface generale au lecteur' Mersenne says "...l'on prendra donc pour une simple narration tout ce que j'ay dit, si l'on ne se sent contraint par les experiences, ou les raisons que i'apporte d'embrasser ce que ie propose."

[13] M. Mersenne, *La Verité des Sciences...*, Paris, 1625, p. 213.

> Ce que ie trouverois bon en sa doctrine, est qu'on feît toutes sortes d'experiences pour découvrir comment les esprits des plantes, et des animaus exercent leurs operations: et quelles sont leurs diverses qualitez, et leur multitude: comment et par quelle vertu les eaus Royalles, fortes, et toutes celles que l'Alchymie nous donne, dissolvent l'or, l'argent, le cuivre, l'étain, le fer et les autres métaus et mineraus: pourquoy elles ne dissolvent pas le verre, les pierres, les plantes etc.[14]

In 1630, Descartes, when asked by Mersenne how to do useful experiments, answered, "A cela je n'ai rien à dire après ce que Verulamius en a ecrit...",[15] but added the qualification, "Pour les plus particulieres, il est impossible qu'on n'en fasse beaucoup de superflües, et mesme de fausses, si on ne connoist la verité des choses avant que de les faire...".[16]

Nonetheless, by the 1660s a Baconian influence was reaching France in a variety of ways. Scarcely an issue of the _Journal des Sçavants_ passed without an extract from the _Philosophical Transactions_. Robert Boyle's popularity among French savants was reflected in the _Journal_[17] and in Cottereau du Clos' weekly examination of the _Tentamina Chimica_ in the physics assembly of the Académie des Sciences between October 1668 and February 1669.[18] Christian Huygens, in one

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[14] ibid., p. 211.

[15] _O.D._, I, 195.

[16] _O.D._, I, 196.

[17] see the _Journals_ of 26 Avril 1666, 16 Août 1666, 6 Décembre 1666, 31 Janvier 1667, 9 Avril 1668, 25 Juillet, 1672.

[18] Archives de l'Académie des Sciences, Registres de Physique, IV, fols. 241ff; VI, fols. 1-30.

of his early plans for the physics assembly of the Académie, proposed, "La principale occupation et le plus utile de cette assemblee doit estre a mon avis de travailler à l'Histoire Naturelle a peu pres suivant le dessein de Verulamius".[19] Examination of the Academy's 'Registres', its annual plans of work and its publications would suggest that Huygens' plan was adopted. In its early years[20] the Academy's emphasis on an experimental study of nature, a 'marriage of the rational and experimental faculty' and a collection of natural histories where there was no hasty attempt to draw general conclusions would suggest a strong Baconian influence.

Pierre Gassendi, in his first published work, Exercitationes Paradoxicae Adversus Aristoteleos, wrote that experience and reason were the mistresses of reality.[21] Later, when he attempted to show how we could have worthwhile knowledge of the world of appearances using Christianized Epicureanism as a hypothetical model, he revived the sensualist and experimental tradition of the ancient atomists. A substantial part of his reputation and influence on his contemporaries was based on the experiments he performed. He was particularly renowned for his untiring observation of the heavens,[22]

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[19] O.H., XIX, 268 and VI, 95-6.

[20] 1666-72. See below, Chapter IX. I have concentrated on the period of the Academy's history which is most relevant to the work of Jacques Rohault.

[21] P. Gassendi, Excercitatones Paradoxicae Adversus Aristoteleos, Paris, 1624; trans. B. Rochot, Dissertations en forme de Paradoxes contre les Aristotéliciens, Paris, 1959p.32/3.

[22] see P. Gassendi, Opera Omnia, 6 vols.,Lyon, 1658, Epistolae quattor de apparente magnitudine solis..., III, 420-77, and Astronomia, IV[a].

experiments on the formation of salts,[23] his experimental 'proof' of the principle of inertia[24] and his repetition and analysis of Pascal's Puy-de-Dôme experiment.[25]

It was the problems associated with this last experiment which preoccupied many European savants in mid-century. French savants, notably Mersenne, Chanut, Descartes, Pierre Petit, Pascal, Florin Périer, Roberval, Gassendi, Auzout, Huygens, Rohault and Mariotte, performed, repeated and thought out a great variety of experiments to discover whether or not the space at the top of an open-ended tube filled with liquid and then immersed in the liquid was destitute of all matter and whether or not atmospheric pressure explained the rise of the column of liquid. Undoubtedly, French experimentalists were inspired and influenced by Italian, Dutch, English and German savants. But their interest and their experiments had a momentum of their own.

In 1644 Mersenne received from François du Verdus and Père J.F. Nicéron the first details of the successful barometric experiment performed by Torricelli and Viviani.[26] Pascal later described

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[23] see Lettres de Peiresc, Gassendi à Peiresc, 6 juillet 1635, IV, 537-40.

[24] see Gassendi, Opera, III, 478-563. Gassendi, with the help of Comte d'Alais, dropped a weight from the mast of a boat anchored in Marseilles harbour and affirmed that it would always fall at the foot of the mast.

[25] see Gassendi, Opera, I, 180ff. and VI, 319a-b. For a report and analysis of Gassendi's experiments performed at Condon, near Toulon, see B. Rochot, "Gassendi et l'Expérience", Histoire de la Pensée, XIII, Mélanges Alexandre Koyré II, pp. 411-22.

[26] see R. Taton, "L'Annonce de l'expérience barométrique en France", Revue d'Histoire des Sciences, XVI, 1963, pp. 77-83.

the experiment:

> ...it was found that a glass tube four feet in height, with one end open and the other hermetically sealed, having been filled with quicksilver and the open end then stopped by a finger or in some other way and the tube placed vertically with the stopped end down and plunged two or three fingers' breadths into some more quicksilver contained in a vessel half full of quicksilver and half full of water; if the stopper is removed, the tube remaining plunged in the quicksilver of the vessel, the quicksilver of the tube descends part way, leaving at the top of the tube an apparently empty space, the bottom of the tube remaining full of quicksilver up to a certain height.[27]

Much intrigued, Mersenne journeyed to Italy late in 1644. In Rome he met Michaelangelo Ricci and in Florence, the experiment was performed for him by Torricelli. On his return to France he and Chanut unsuccessfully attempted to repeat Torricelli's experiment. In 1646 Pierre Petit brought news of the experiment to the Pascals at Rouen and there, with the aid of the Rouennais glass makers, they met with success.[28]

Thereafter the experiment and a large number of its modifications took hold of the imagination and practice of French savants, involving them in abusive controversies. Pascal recounted how Mersenne had publicized the experiment throughout France, "to the admiration of all the learned and curious".[29] Mersenne's letters to Constantyn Huygens in Holland aroused the interest of the young

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[27] R.M. Hutchins, ed., Great Books of the Western World, vol. 33, B. Pascal, New Experiments concerning the vacuum, trans. R. Scofield, p. 359.

[28] Oeuvres de Blaise Pascal, eds., L. Brunschvicg and P. Boutroux, 14 vols., Paris, 1908-25, Lettre de Pierre Petit à Chanut sur la Première Expérience de Rouen, 19/26 Nov. 1646, I, 329-45. Petit's letter was published as Observations touchant le Vuide by M.A. Dominicy in 1647.

[29] Great Books, 33, 359.

Christian Huygens.[30] He sent letters to Sweden to Descartes and Chanut and proposed experiments to determine if sound could be heard or if animals such as cats, birds and flies could live in the apparently empty space at the top of the tube.[31] Roberval sent news to Desnoyers in Poland[31a] and Bourdelot to dal Pozzo in Italy.[32] Roberval accused Valérien Magni, a capuchin priest in Warsaw, of plagiarism and threw a bombshell into the learned world when, at Bourdelot's academy in March 1648, he performed his experiment with a carp's bladder and established 'the spontaneous elatery of the air'.[33] Pascal crossed metaphorical swords with Descartes[34] and answered the objections of Etienne Noel S.J. first with polite

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[30] see O.H., I, 77, 84, 91.

[31] see M. Mersenne, Reflectiones Physico-mathematicae, Paris, 1647, cap. IV, p. 90. Cited in Brunschvicg, Oeuvres de Pascal, II, 12. See also, Gassendi, Opera, Lyon, 1658, I, 206.

[31a] see Roberval's letters to Desnoyers, 12 Oct. 1647 and 15 May 1648, in Brunschvicg, Oeuvres de Pascal, II, 21ff. and 295ff.

[32] Archives de la Cisterna, ms.31, fols. 178, 184, 186vo. Cited in R. Pintard, "Autour de Pascal: l'Académie Bourdelot et le problème du vide", Mélanges offerts à Daniel Mornet, Paris, 1951, pp. 76-8.

[33] see Brunschvicg, Oeuvres de Pascal, II, 295ff; J. Pecquet, New Anatomical Experiments, London, 1653, pp. 92-101; Mélanges offerts à Daniel Mornet, p. 78.

[34] see Descartes. Correspondance, ed. C. Adam and G. Milhaud, 8 vols., Paris, 1936-63, VII, 378-81, VIII, 253.

irony and then with a mockery and bitterness unworthy of his scientific genius.[35]

Of the French group the most impressive was Blaise Pascal. It was he who provided with clarity and concision an ordered synthesis of the experimental phenomena in his Experiences Nouvelles Touchant le Vuide,[36] Récit de la Grande Expérience de l'Equilibre des Liqueurs[37] and Traitez de l'Equilibre des Liqueurs et de la Pesanteur de la Masse de l'Air.[38] He claimed that the evidence of experiments forced him

> to quit opinions to which respect for antiquity had held me. Accordingly I but quitted them little by little, and only gradually did I give them up, for from the first of these three principles, that nature has an invincible horror of the void, I passed to the second, that she feels horror but not invincibly; and thence I finally came to believe in the third, that nature has no horror of the void.[39]

In any description of Pascal's contribution to the French experimental movement it should be noted that when he gave an exposition of his experiments and their consequences for hydrostatics he did so in a synthetic manner which idealized experiments

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[35] see Pascal's Answer to the Very Good Reverend Father Noël, Rector, of the Society of Jesus, Paris, and the Letter from Pascal to M. Le Pailleur, Concerning Father Noel, Jesuit, in Great Books, 33, pp.365-81.

[36] Pascal, Expériences Nouvelles..., Paris, 1647. Printed in Brunschvicg, Oeuvres de Pascal, II, 59ff.

[37] Brunschvicg, Oeuvres de Pascal, II, 365-73.

[38] ibid., III, 156-266.

[39] Great Books, 33, Account of the Great Experiment..., 389.

he had performed and used experiments he could not have performed. Roberval noticed that small air-bubbles rose in columns of mercury, wine and water. Pascal did not pay attention to this experimental evidence, to the imperfections of the liquids, but reasoned, as A. Koyré points out,[40] as if the liquids used in his experiments were 'perfect, continuous and homogenous'. Furthermore, as Boyle asserted, many of Pascal's experiments were more ingenious than practical. They were 'thought-experiments'. Book six of the Traité de l'Equilibre des Liqueurs entitled "Des corps compressibles qui sont dans l'eau" includes experiments with a twenty foot long tube attached to a bellows, a balloon filled with mercury and the thigh of a man who is sitting "dans une cuve plein d'eau".[41]

Do these criticisms negate Pascal's claim to have built on the evidence of experiments or are they explained by Pascal's desire to set out his results in a conclusive synthesis which would demolish the objections of his opponents? The most damaging criticism is that which shows Pascal neglecting the experimental evidence of the air-bubbles. It follows from this that Pascal was easily convinced "that nature has no horror of the void". As he admitted in his letter to Périer, before the Puy-de-Dôme experiment

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[40] A. Koyré, Metaphysics and Measurement, London, 1968, Pascal Savant, pp. 131-56.

[41] Brunschvicg, Oeuvres de Pascal, III, 183. These experiments may have been impractical but they were not impossible. Mariotte later repeated many of them.

was performed,

> it is hard for me to believe that nature, which is not animate or sensitive, is capable of horror, since the passions presuppose a soul capable of feeling them, and I incline much more to impute all these effects to the weight and pressure of the air, because I consider them only as particular cases of a universal proposition of the equilibrium of fluids...[42]

His inclination disposed him to interpret his experiments in a certain way.

At the same time, it is obvious that experiments contributed a great deal to his work in physics, and that he was an effective propagandist of the experimental method. It could be argued that he built on, but not only on, the evidence of experiments. He confirmed and invalidated hypotheses and composed his classic Traitez using clearly conceived experiments meticulously performed and a deductive logic of great penetration. His work, since he presented it as the result of his experiments, publicized the value of the experimental method. Experiments, he said, are the true masters to follow in physics.

> Les secrets de la nature sont cachés; quoiqu'elle agisse, on ne découvre pas toujours ses effets; égale à elle-même, elle n'est pas toujours également connue. Les expériences qui nous donnent l'intelligence multiplient continuellement; et comme elles sont les seuls principes de la physique, les conséquences multiplient à proportion.[43]

Mersenne, Gassendi and Pascal were stalwarts of the French experimental movement. They were ably supported by a host of lesser

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[42] Great Books, 33, 383.

[43] Brunschvicg, Oeuvres de Pascal, Préface sur le Traité du vuide, II, 136.

figures such as Fabry de Peiresc, Ismael Bouilliau, Chapelain, Sorbière, Bourdelot, Roberval, Auzout, Petit and Jean Pecquet. Pierre Petit, for example, was described to Huygens as a man "qui a tousjours des Ouvriers ches luy pour y travailler".[44] Petit made clear his interest in experiments in his letter to Chanut of November 1646 describing the successful performance of the Torricellian experiment at Rouen.

> Je ne me serois iamais advisé de vous en tant escrire, si le Pere Mersenne ne m'eut asseuré que vous aviez voulu faire ensemble la mesme experience. Je croy que vous aurez veues celles que nous avons faites M. Gassendy et moy, pour la cheute des corps dans la balance, et je voudrois avoir le loisir de donner au jour celles que j'ay faictes sur les pesanteurs et refractions de presque tous les corps diaphanes, solides et liquides, vous y verriez de l'exactitude et de la nouveauté dont on pourra tirer de beaux principes de physique.[45]

Jean Pecquet, in his Experimenta Nova Anatomica,[46] continually evoked the 'testimony of experience' to demonstrate his discovery of the receptacle and motion of the chyle: dissections on dogs, horses, swine, sheep, geese and "experiments physico-mathematical".[47]

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[44] O.H., Jean Chapelain à C. Huygens, 30 Octobre 1658, II, 267.

[45] Brunschvicg, Oeuvres de Pascal, I, 343.

[46] Pecquet, Experimenta Nova Anatomica, Paris, 1651; 2nd edition with additions, Paris, 1654. The 1651 edition was translated as New Anatomical Experiments and published in London in 1653.

[47] Pecquet, New Experiments, London, 1653, p. 93. Pecquet's purpose, in this instance, was to show how 'diastolic attraction' failed to explain the motion of the blood. The experiments included Roberval's with a carp's bladder (pp. 92-101), Pascal's on Puy-de-Dôme (pp. 101ff) and Auzout's of 'vacuity in vacuity'(pp.104-9).

He wrote, "Nisi mihi constitutum foret ex vulgaribus sententiis eam duntaxat sapientiam admittere, cui suffragetur experientiae testimonium".[48]

Despite temporary setbacks, the strength of the experimentalists increased in the 1660s. They formed a powerful lobby in the conferences of Montmor, Thevenot, D'Aubignac, de Launay and J.B. Denis. Montmor's academy, for example, showed an intense interest in experiments, especially between 1661 and the last year of its existence, 1664.[49] Huygen's correspondence records their interest in instruments, experiments on the 'vacuum' and "...les experiences de chymie".[50] Samuel Sorbière, in a Discours prononcé le 3 d'Avril 1663. A l'ouverture de l'Academie des Physiciens, qui s'assemblent tous les Mardis chez Monsieur de Montmort,[51] gave an account of the discord which divided Montmor's conferences, a discord fomented by those who provoked vain disputes and by those who were forever preaching the virtues of experiments. The remedy, Sorbière felt,

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[48] Pecquet, Experimenta, Paris, 1654, p. 84. This edition includes a letter of praise from Auzout of March 1651. "Melioribus sub auspiciis militas (Carissime Pecquete) cumque non ignores in Physica si quid scimus nihil scire praeter Experimenta et observationes, eaque quae ex ipsis juxta principia Metaphysica et Mechanica deducuntur; liberiorem nactus animum, aliam viam instituis et cum ipsa Natura congrederis, eamque tuis Experimentis quasi denudas, ut ea, quae latere voluit nisi penitus inquirentes, observes" (pp. 103-4).

[49] O.H., Huygens à Robert Moray, 12 juin 1664, V, 70. See also B.N. Fonds Latin 10352, Sorbière à D. Renato Francisco Slusio, fol. 365vo. The academy appears to have revived for a short time in 1667. See B.N. F.Fr. 15189 fol. 143vo.

[50] see O.H., IV, letters 861, 873, 896, 998, 1008, 1108, 1167, 1186, 1192.

[51] B.N. Cinq Cents de Colbert 485 fols. 441-5 and Bigourdan, Réunions Savantes, (see Chapter III, note 19).

was to remain true to "...nos premieres resolutions, qui estoient de faire un docte et judicieux meslange des experiences et des raisonnemens".[52] He emphasised that the experimentalists must realise the Academy had neither the space nor the funds to implement a programme of continuous experimental research. Only government support would permit such a programme and till that happened the arts and sciences would have to remain in a state of imperfection. No one, he chided, was forbidden,

> ...de preparer chez luy tout à loisir ce qui lui seroit necessaire, et de faire apporter icy le jour que nous nous assemblons toutes ses machines. On a veu mesme avec plaisir Monsieur Rohault venir icy avec tout son equipage d'Aymant; et Monsieur Pecquet y prendre ses habits de ceremonie, pour proceder selon sa methode et à ses dissections; Monsieur Petit y a fait jouer son artillerie avec de la poudre à canon, et avec l'or fuminant; Monsieur Thevenot y a fait voir ses tuyaux faits exprès pour examiner l'ascension de l'eau, qui monte d'elle-mesme hors de son niveau...[53]

The crowning glory of the experimentalists was not, however, the multi-purpose Parisian conferences but the Académie des Sciences. As we shall see later, 'Registres', annual plans of work and publications, show that the most striking characteristic of the Academy's early years was its love of the particular, the individual discovery, the natural history, the experimental study of nature.

The important point is that Rohault flourished when French and European savants bowed before the altar of experimentation.

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[52]Bigourdan, op. cit., p. 162.

[53]ibid., pp. 216-17.

The contemporary interest in experiments exerted a strong influence on his natural philosophy. It directly influenced the composition of his Traité de Physique. Rohault adorned his work with examples drawn from his own experience, with experiments performed by himself and with experiments performed by European scholars. He made use of the experiments of Steno, Asselli, Harvey, Descartes, Pecquet and Gayant in his description of the body of man.[54] In astronomy he used the observations and work of Galileo, Huygens and J.B. Cassini to explain the appearances of Venus, Mars, Jupiter and Saturn and to experimentally verify the Copernican hypothesis. He mentions that Galileo had observed that Venus had a round figure when it appeared large and a horned figure when it appeared small (the phases of Venus), a phenomenon explained by that planet's revolution about the sun.[55] He states that Galileo was the first to observe four small stars, the Medicean stars of Jupiter and the changing figure of Saturn.[56] He refers to Cassini's observations and measurements of 1665 and 1666 confirming the discovery of Jupiter's satellites and the displacement of spots on Jupiter and Mars showing that these planets turned about their own centres.[57]

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[54] see Chapter IV, notes 63-72.

[55] Rohault, Traité, II, 14, 55.

[56] ibid., II, 16, 61.

[57] ibid., II, 16, 61-3. Cassini had published his results in the Journal des Sçavans of 22 Fév., 1666 and 31 May, 1666.

He describes how Galileo and 'a great many philosophers' were unable to find the cause of the 'alterations of the figure of Saturn' but lately 'Mr Hugens' had "thought of an Explication... by supposing that Saturn is a spherical Body, surrounded at a certain distance, by a very thin Ring but of a considerable Breadth, the Plane of which passes through the Center of Saturn; and he supposes this Ring, as well as Saturn itself, to be illuminated by the Sun".[58]

Huygens' abilities were quickly recognized by French natural philosophers and Rohault was no exception. "Huygens passe pour le plus scavant homme que nous ayons en fait de mechanique",[59] wrote the anonymous author of a collection of anecdotes; "M. de Rohault en fait un tres grand cas".[60] In part two, chapter 28 of his Traité, Rohault showed how his Law of nature, "Que les parties d'un Tout qui se meut en rond alentour de son centre, tendent à s'en éloigner...",[61] could be applied to the mass composed of earth, water and air to describe gravity and levity. To confirm his opinion he used "une belle experience dont nous avons l'obligation à M. Hugens".[62] The experiment consisted of taking a round, white,

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[58] Rohault, System, II, 16, 45-6.

[59] B.N., F.Fr., n.a., 4333 fol. 372 vo. Montmerqué bought this collection of mss., entitled, Recueil de choses diverses, in 1828/9. It would appear to date from 1673/5.

[60] loc. cit.

[61] Rohault, Traité, II, 28, 121.

[62] ibid., II, 28, 121-2.

flat-bottomed vessel, seven or eight inches in diameter and three inches high, filling it with water and adding a small amount of powdered Spanish wax. Then, having covered the vessel with glass and sealed the two "pour empêcher que rien n'en puisse échaper",[63] it was attached to a pivot and made to turn round. The wax, which had sunk to the bottom of the vessel, moved faster than the water and was forced out to the vessel's sides. The vessel was stopped suddenly and it was found that the wax, rubbing against the sides, slowed down at a quicker rate than the water. It is at this moment that the water resembles the fluid matter surrounding the Earth and the wax resembles parts of the Earth which we see descending in the Air. For the wax was forced to the centre of its motion, to the centre of the vessel, chased there by the faster outward moving particles of water, "et là elle s'assemble en une petite masse ronde, semblable à la Terre".[64] Huygens later reclaimed his experiment, "parce que parmy mes pensées, il mesle aucunement celles de Mr Des Cartes, et les sienes propres, et qu'il omet plusieurs choses qui apartienent à cette matiere, dont il y en a qu'il ne pouvoit pas sçavoir...".[65] Rohault, he said, had seen and heard him perform and explain the use of the experiment and had recognized its value, "(ainsy qu'il la reconnoit avec ingenuité)".[66]

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[63] ibid., II, 28, 122.

[64] ibid., II, 28, 123.

[65] O.H., Discours de la Cause de la Pesanteur, preface, XXI, 446.

[66] loc. cit.

In even greater detail Rohault followed the work of Pascal in aerostatics and hydrostatics. He used a rich variety of experiments of his own invention, experiments inspired by Pascal, Roberval and Auzout to demonstrate the 'weight of air' and to confirm his own cartesian suppositions. In chapters twelve and sixteen of the first part of his Traité he enunciated principles of aerostatics and hydrostatics established by Pascal in his Traitez de l'Equilibre des Liqueurs et de la Pesanteur de la Masse de l'Air, for instance, 'that liquids weigh in proportion to their height[67]...a body in water is counterpoised by an equal volume of water[68]...that the mass of the air is heavy,[69] that its weight is limited,[70] that it is heavier at one time than at another,[71] that it is heavier in certain places than in others,[72] as in valleys, that it presses with its weight all the bodies it surrounds, and presses the more the heavier it is'.[73] Chapter twelve, "Des mouvemens que l'on a coûtume d'attribuer à la crainte du vuide", most easily corresponds to Pascal's Traité de la Pesanteur de la Masse de l'Air, chapter sixteen

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[67]Rohault, concerned with defending cartesian theory, described his principles less clearly than Pascal, particularly those on the equilibrium of liquids. See B. Pascal, Treatise on the Equilibrium of Liquids, Great Books, 33, 390, 395, and Rohault, Traité, I, 12, 78, 82.

[68]Pascal, Equilibrium of Liquids, Great Books, 33, 398, and Rohault, Traité, I, 16, 121.

[69]see B. Pascal, Treatise on the weight of the mass of the air, Great Books, 33, 405ff., for what follows. See also, Rohault, Traité, I, 12, 74.

[70]Rohault, Traité, I, 12, 78.

[71]ibid., I, 12, 89.

[72]ibid., I, 12, 90-1.

[73]ibid., I, 12, 75-6.

"Des corps durs plongés dans les liqueurs", to chapter five, "Des corps qui sont tout enfoncez dans l'eau", of Pascal's Traité de l'Equilibre des Liqueurs.

Rohault reproduced most of the classic 'vacuum' experiments and nearly all those with water, mercury and air mentioned in Pascal's second treatise: experiments with bellows,[74] syringes,[75] suction by mouth,[76] respiration,[77] cupping-glasses,[78] siphons,[79] glass tubes.[80] Roberval's experiment with a carp's bladder[81] and Pascal's two most celebrated experiments, 'Puy-de-Dôme'[82] and 'le vide dans le vide',[83] were repeated by Rohault and given a cartesian interpretation. To show that his reasoning "que le vif argent doit s'arrester à diverses hauteurs en des lieux diversement élevez"[84] accorded with experience Rohault filled a three and a half foot long tube with mercury, reversed it in "un vaisseau assez

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[74]ibid., I, 12, 97.

[75]ibid., I, 12, 72-9.

[76]ibid., I, 12, 98.

[77]ibid., I, 12, 97-8.

[78]ibid., I, 12, 98-9.

[79]ibid., I, 12, 95-7.

[80]ibid., I, 12, 79ff.

[81]ibid., I, 12, 87-8.

[82]ibid., I, 12, 90-2.

[83]ibid., I, 12, 92-5.

[84]ibid., I, 12, 90.

creux et fort étroit, dans lequel il s'est vuidé à l'ordinaire"[85] and enclosed it in "une pièce de bois que j'avois fait faire exprès"[86] to enable him to carry it easily from place to place. He then measured the level of the mercury on the banks of the frozen Seine and 36 'toises' higher, at the top of one of the towers of Nôtre-Dame and noted that the mercury level had fallen nearly three 'lignes' (¼"). He says "On a fait à peu-près la mesme chose en Auvergne" in the town of Clermont and on the mountain called Puy-de-Dôme.[87]

Rohault cared for and manipulated his quality instruments with the competence of an efficient technician.[88] His ability to design instruments, perform experiments and repeat them at will, especially in his conferences, no doubt encouraged him in this direction. Notable examples of his experimental dexterity are his discovery of the easy ascent of a liquid in very thin glass tubes[89] (a phenomenon later called capillary attraction), his construction of an artificial eye to illustrate his theory of vision,[90] and his invention to

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[85] ibid., I, 12, 90-1.

[86] ibid., I, 12, 91.

[87] loc. cit.

[88] see B. Pascal, Traité de l'Equilibre des Liqueurs, 2nd edit., Paris, 1664, preface; Rohault, Oeuvres Posthumes, preface; A.N. Minutier Central, 39, 127, L'Inventaire de Jacques Rohault; O.H., XXII, 536.

[89] Rohault, System, I, 22, 148 and Oeuvres Posthumes, Traité de Méchanique, p. 594.

[90] Rohault, Traité, I, 31, 328-30, and A.N. Minutier Central, 39, 127, L'Inventaire de Jacques Rohault.

facilitate performance of the experiment of 'vacuity in the vacuity'.[91] The latter was similar to the apparatuses of Pascal, Auzout and Roberval.[92]

Rohault's love of experimentation was further encouraged by his reading of Descartes. The experiments in his Traité inspired by Descartes, Descartes' exhortation to his followers to fill in the experimental details of his system and the possibility of deriving from Descartes the general methodological sketch of the preface and early chapters of the Traité is the evidence and argument that can be used to support this view.

Rohault claimed that what had hindered the development of natural philosophy to his own day was the use of a faulty method. In his studies he found that natural philosophers blindly submitted to the sentiments of antiquity, were preoccupied with metaphysics, grossly neglected mathematics and either depended wholly on the strength of their reasoning or went to the other extreme and attempted to reduce everything to experimentation. Too complete a reliance on reason led them into vain disputes, prevented their discovery of new things and the confirmation of their deductions. Whereas those who relied totally on experiments deprived "themselves of the liberty of drawing conclusions"[93] and thus could not recognize a whole

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[91] Rohault, Traité, I, 12, 92-3.

[92] For an account of the similarities, see P. Mouy, La Physique Cartésienne, pp. 128-9.

[93] Rohault, Traité, preface, not pag.

string of truths which "often can be deduced from a single experiment".[94] The right method for the natural philosopher, then, was to marry the two means of knowledge, combine reason with experiment.

Experiments had a crucial role in Rohault's method. While he was aware that they only let him know "les choses grossières et sensibles",[95] he stressed "Les experiences sont...necessaires pour l'établissement de la Physique".[96] In the preface he classified them according to three types: those which his senses registered but which he did not think immediately of applying, those where, having planned carefully without knowing or foreseeing the result, he proved something, and finally, those whereby his previous reasoning was confirmed or rejected. The last sort, he claimed, were particularly useful (to the physicist) but the other two were not worthless. They increased the sum total of knowledge, provided the occasion for making first conjectures and led him away from the paths of erroneous thought.

In part one, chapter three, Rohault repeated and extended what he said in his preface by underlining the hypothetical nature of his method. The natural philosopher sought "what the Nature of any Thing is" by searching for "some one Particular in it, that will

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[94] loc. cit.

[95] loc. cit.

[96] loc. cit.

account for all the effects which Experience shows...it is capable of producing".[97] His procedure, said Rohault, is a tentative one since it is possible that there are "different causes capable of producing the same Effect".[98] His conjecture could only be held as very probable when it accounts for every property and when it is not contradicted by even one experiment. It is the more probable "by how much the more simple it is, by how much the fewer Properties were had in view, and by how much the more Properties, different from each other, can be explained by it".[99] And may be considrred the very truth when it explains so many and so different properties of a thing that it is difficult to believe that they can be explained in two different ways. For the most part, however, he has to be content with finding out "how Things may be", not "what they really are".[100] Experience, then, was very important for the natural philosopher. It was a source of his early hypotheses, could lead him to new discoveries, and provided him with evidence by which he could retain, reject, confirm or falsify his explanations.

Such a view of the role of experiments and of hypotheses was compatible with what Descartes had written.[101] Rohault offered

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97 Rohault, System, I, 3, 13.

98 ibid., I, 3, 14.

99 loc. cit.

100 loc. cit.

101 It must be remembered that I am not attempting to decide which side of the conceptualist-empiricist balance Descartes falls on or to examine in detail the argument that his views on method "...exhibit a fascinating chiaroscuro" of the two ways of scientific reasoning. (see G. Buchdahl, Metaphysics and the Philosophy of Science, Oxford, 1969, pp. 82-3.)

his system of natural philosophy as having been deduced from a small number of 'self-evident' truths. But he had to demonstrate the strength of its explanatory powers and to show that it agreed with experience, especially since it 'descended to particulars'. In the end, he used his experiments to illustrate and defend his cartesian theories. Our argument for the compatibility of Rohault and Descartes' methodological prescriptions, however, should be viewed in the context of an attempt to account for the empirical appearance of the Traité de Physique.

In the French edition of the Principes Descartes stated that he desired to deduce from his principles the explanation of all natural phenomena, "c'est à dire des effets qui sont en la nature, et que nous appercevons par l'entremise de nos sens".[102] What is perceived by the senses as effects of the material world is what the natural philosopher seeks to explain. Sense experience, empirical observation thus set a physical limit to the task he set himself. Furthermore, Descartes claimed that, given experimental data on the magnet and the anatomy of the human body,[103] he was able to guide and test his deduction of the nature of the magnet and the motion of the blood. In either of these two cases Descartes may be said to agree with Rohault that experiments were "the Occasion of making the first Conjectures concerning the Nature of those Subjects which Natural Philosophers are conversant about".[104]

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[102] O.D., IX-2, nouvelle présentation, Paris, 1964, III, 1, 103.

[103] O.D., Discours de la Méthode, VI, 47 and Regulae, X, 427.

[104] Rohault, System, preface, not pag.

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[102] *O.D.*, IX-2, nouvelle présentation, Paris, 1964, III, 1, 103.

[103] *O.D.*, Discours de la Méthode, VI, 47 and Regulae, X, 427.

[104] Rohault, *System*, preface, not pag.

Experiments entered Descartes' method mainly when his studies progressed from the discovery of general principles to an examination of particular Effects and when they were needed to choose between a variety of possible hypotheses. One of the most famous passages which supports this interpretation occurs in the sixth part of the Discours de la Méthode.

> ...lorsque i'ay voulu descendre a celles qui estoient plus particulieres il s'en est tant presenté a moy de diverses, que ie n'ay pas creu qu'il fust possible a l'esprit humain de distinguer les Formes ou Especes de cors qui sont sur la terre, d'une infinité d'autres qui pourroient y estre, si c'eust esté le vouloir de Dieu de les y mettre, ny, par consequent, de les rapporter a nostre usage, si ce n'est qu'on viene au devant des causes par les effets, et qu'on se serve de plusieurs experiences particulieres. En suite de quoy, repassant mon esprit sur tous les obiets qui s'estoient jamais presentez a mes sens, j'ose bien dire que ie n'y ay remarqué aucune chose que je ne peusse assez commodement expliquer par les Principes que i'avois trouvez. Mais il faut aussy que i'avoue, que la puissance de la Nature est si ample et si vaste, et que ces Principes sont si simples et si generaux, que je ne remarque quasi plus aucun effect particulier, que d'abord ie ne connoisse qu'il peut en estre deduit en plusieurs diverses façons, et que ma plus grande difficulté est d'ordinaire de trouver en laquelle de ces façons il en depend. Car a cela ie ne sçay point d'autre expedient, que de chercher derechef quelques experiences, qui soient telles, que leur evenement ne soit pas le mesme, si c'est en l'une de ces façons qu'on doit l'expliquer, que si c'est en l'autre.[105]

Descartes' knowledge advanced as he discovered more and more properties of, for example, the magnet, the rainbow and the snow-flake and as he was able to provide crucial experimental tests of the various explanations that might be deduced from his principles.

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[105] O.D., VI, 64-5.

Thus Descartes' experiments 'could lead him to new discoveries and provided him with evidence by which he could retain, reject, confirm or falsify his explanations'.

Rohault's belief in the probabilistic nature of most scientific enquiry was reflected in part four of the Principes, where Descartes distinguishes between 'moral' and 'absolute' certainty. Absolute certainty, Descartes says in article 206, is founded on the metaphysical principle ("tres-assuré") that God is the guarantor of our ability to distinguish truth from falsehood. This certitude extends to "tout ce qui est demonstré dans la Mathematique...à la connoissance que nous avons qu'il y a des corps dans le monde...à toutes les choses qui peuvent estre demonstrées, touchant ces corps, par les principes de la Mathematique ou par d'autres aussi évidens et certains...",[106] including those he has dealt with in the Principes, "au moins les principales et plus generales".[107] 'Moral' or 'sufficient' certainty, on the other hand, arises because of God's unlimited powers to arrange natural phenomena in an infinity of diverse ways and particularly applies to his (Descartes') explanation of the effects of the 'insensible' parts of natural bodies. Thus, like Aristotle, he is satisfied with his explanations.

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[106] O.D., IX-2, nouv. prés., IV, 206, 324.

[107] loc. cit.

> si les causes que j'ay expliquées sont telles que tous les effets qu'elles peuvent produire se trouvent semblables à ceux que nous voyons dans le monde, sans m'enquerir si c'est par elles ou par d'autres qu'ils sont produits.[108]

Our argument in favour of Descartes' influence on Rohault's love of experimentation is supported further by the frequent occurrence, in Rohault's _Traité_, of experiments taken directly from and inspired by Descartes. Many of the experiments contained in Descartes' _Météores_, for example, were included in part three of the _Traité_: an experiment with an aeolipile to confirm their explanation of winds,[109] how "...le grand bruit, comme des cloches ou des canons, peut diminuer l'effect de la foudre",[110] an account of Descartes' observations of the shapes of hail-stones and snow-flakes,[111] an explanation of 'mists'[112] and 'manna',[113] and the use of a glass globe filled with water to explain the properties of the rainbow.[114] Other examples, notably the inspiration of Rohault's

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[108] ibid., IV, 204, 322.

[109] _O.D._, Les Méteores, Discours IV, VI, 265-7, and Rohault, _System_, III, 11, 206-7.

[110] _O.D._, Les Méteores, Discours VII, VI, 320, and Rohault, _System_, III, 16, 223-4.

[111] O.D., Les Méteores, Discours VI, VI, 293-308, and Rohault, _System_, III, 14, 213-17.

[112] _O.D._, VI, 309-10, and Rohault, _System_, III, 14, 217.

[113] _O.D._, VI, 310, and Rohault, _System_, 15, 219.

[114] _O.D._, VI, 325ff., and Rohault, _System_, 17, 225ff. This experiment was not new. Witelo (13th century), Theodoric of Freiberg (_De Iride et radialibus impressionibus_), and De Dominis (_De Radiis Visus et Lucis in Vitris perspectivis et Iride_, Venice, 1611) had studied the passage of a ray of light through a globe filled with water.

discovery of capillary attraction[115] and his demonstration of the properties of the magnet,[116] may be found in the Principes. Rohault reproduced Descartes' experiments with magnets and iron filings,[117] compass needles,[118] "une pirouëtte de fer",[119] "les pincettes qui servent à attiser le feu"[120] and two magnets suitably positioned, one of which is situated in "un petit bateau",[121] or in Descartes' case, "une petite gondole",[122] floating on water.

It is worth noting, however, that the nature of the evidence has prevented the establishment of a causal link between the empirical appearance of Rohault's Traité and the influence of Descartes and the current trend of French natural philosophy. Why Rohault made this particular interpretation of Descartes, why an environment favourable to empiricism should have meant that he became enamoured with experiments and ultimately, why he chose to give experimentation a privileged position in his Traité, are questions to which precise answers cannot be given. Nonetheless, within the limits of the evidence available, we have described the major influences which encouraged Rohault's own choice and inclination: namely, the work of René Descartes, Christian Huygens and Blaise Pascal.

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[115] see O.D., IX-2, nouv. prés., IV, 19, 209-10 and Rohault, System, I, 22, 140-8.

[116] see O.D., IX-2, nouv. prés., IV, 133-83, 271-305, and Rohault, System, III, 8, 163-87.

[117] O.D., IX-2, nouv. prés., IV, 179, 302-3, and Rohault, System, III, 8, 177ff.

[118] O.D., IX-2, nouv. prés., IV, 165, 293-4 and Rohault, System, III, 8, 165, 173.

[119] O.D., IX-2, nouv. prés., IV, 174, 299, and Rohault, System, III, 8, 182-3.

[120] Rohault, _Traité_, III, 8, 216.

[121] Rohault, _Traité_, III, 8, 216.

[122] _O.D._, IX-2, nouv. prés., IV, 170, 297.

CHAPTER VII

CONCEPT OF SCIENCE

The Traité de Physique was Rohault's attempt to satisfy a number of natural philosophers who were searching for an all-explanatory system which would account for known experiments and observations. Its skeletal framework was the mechanistic philosophy of Descartes. The cartesian system was what Rohault chose to replace the Aristotelian one. Its flesh was a large number of experiments inspired by Descartes, Pascal and Huygens among others, by contact with artisans, arranged, performed and used by Rohault himself. It reported how Rohault saw the matter, method and purpose of his subject and how he practised it. But a fuller analysis of his theory and practice is achieved by using other sources: Oeuvres Posthumes, Entretiens sur la Philosophie, letters and more warily, the Fragment de Physique and Fedé's notes to the conferences of 1660 and 1661.

Rohault's concern was with "the knowledge of natural things",[1] the examination of "all that we conceive any way to belong to material Things",[2] "to explain as well the Causes by the Effects, as the Effects by the Causes".[3] Limiting himself to "le pur ordre de la

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[1] Rohault, System, preface, not pag. See also Bib. S$^{te.}$ Geneviève, 2225 fol.1vo and B.N. F.Fr. 14837, Entretiens sur la philosophie, fol.239.

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Nature"[4] and to the order which reason (which was natural to man) made of the material world, he reduced metaphysical preliminaries to a minimum, banished from the demesne of his physics final causes or the sort of questions treated by theologians, "those who are of a higher Profession than that of mere natural Philosophy",[5] the defective method of the alchemists whose "Science extends no further than to give Names to Things whose Natures they understand not",[6] and of the astrologers who rashly take "that for the Cause of an Effect, which really is not, but is only mere Chance and Hazard".[7]

In theory, since the aim of his physics was knowledge of all natural things by means of the right method, his science was as universal as Descartes'. Certainly by giving, if only briefly, the metaphysical foundations to his physics he could enter the eucharist and beast-machine controversies when the need arose. But the *Traité*, except implicitly, did not contain an elaborate description of how he saw his subject matter. He was content to leave aside the type of question which asked whether or not "there be any such thing as Physicks".[8] In practice his physics was universal. The *Traité* embraced all the natural sciences or more precisely, since

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[4] B.N. F.Fr., 14837, Entretiens sur la philosophie, fol. 266.

[5] Rohault, *System*, I, 7, 24.

[6] ibid., I, 20, 110.

[7] ibid., II, 27, 91.

[8] ibid., I, 1, 1.

the time at his disposal was limited, was restricted to an examination of the general principles of natural things, the properties of celestial and terrestial bodies and a brief description of the internal parts of the human body. Thus the emphasis shifted away from Descartes' visionary breadth.

Rohault's epistemology, at least on a general plane, had a strikingly 'modern' appearance. He proclaimed that, in his approach to physics, he laid aside former prejudices and fitted the material world into a mechanistic framework using explanations which, even if no more than highly probable, were nonetheless based on detailed observations and sound logic. In the preface to the Traité, he described his method as the right mixture of mathematical reasoning and experiment. He thought that the progress of the natural sciences would be assured if the physicist remedied four defects in his method.

The outworn habits of the schools ("les écoles") inculcated a lazy, unquestioning, respect for the book-learning of the Ancients which smothered all enterprise and native wit. Too much time was wasted, interpreting, for example, the works of Aristotle, instead of studying Nature itself. "Il y a mesme mille choses qu'elle dit nettement, à qui les veut entendre;".[9]

Secondly, students of physics, content to explain the effects of nature using 'occult qualities' and generalisations which only covered their ignorance and intellectual snobbery, treated their

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[9] Rohault, Traité, preface, not pag.

subjects on a much too abstract, metaphysical, level. What good was prolonged discussion over the divisibility of matter[10] when the physicist knew that matter might be divided into small enough parts to serve all his needs, and when the important thing for a useful science was to descend as soon as possible to a study of particulars and to search carefully for "ce qui peut déterminer la matiere à un tel effet plûtost qu'à un autre...".[11]

The third barrier to the advancement of a detailed study of nature was the extreme positions of 'pure deduction' and 'experiment for experiment's sake'. To proceed, it was necessary to find the right blend of experimentation and reasoning. One of the most important consequences of this mixture is that it could discover the truth or falsity of physicists' conjectures. The physicist reasons that if having considered the effects of a certain subject and having formed an idea of what makes it capable of these effects, then, if what he knows is true, arranging his subject in a particular manner, he should discover a new effect which he had not thought of before. To test his 'deduction', all that remains is for him to perform the experiment and see if the result is as he expected.

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[10]This was a criticism of Cordemoy who propounded the 'heresy' that there existed "...petits corps estendus dont chacun fait une substance a part qui est Indivisible par ce quelle est une...". (Chartres, 366, Clerselier à Desgabets).

[11]Rohault, Traité, preface, not pag.

The fourth methodological defect of natural philosophers was their neglect of mathematics, the use of which was recommended by the Ancients, exercised the mind and enabled it to discern truth from falsity, accustomed the physicist to consider the figure of bodies and ready to know their different properties, and was the means by which the Moderns had made their finest and most particular discoveries and by which artisans had made theirs. Mathematics "est le moyen le plus seur pour trouver quelque chose de nouveau, que de sçavoir ce qui a déja ésté trouvé, et comment il a esté, par les autres".[12]

To these four characteristics of Rohault's method it is possible to add others.[12a] He believed in the tentative nature of scientific enquiry and in the possibility of continuing progress as long as the physicist remained impartial and open-minded. In chapter three he described the different degrees of probability of different conjectures and thus put the 'truth' of the physicist's judgements on a relative plane, a position which appears to be confirmed by what he wrote at the end of parts one, three and four. There he said that he was satisfied that the way of his principles

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[12] loc. cit. Rohault adds that natural philosophers also suffer from the opposition of petty-minded critics "...qui se veut signaler..." by appealing to "...quelque vieille maxime, ou erreur populaire qui flate les oreilles du commun des demy-sçavans...".

[12a] see Savinien de Cyrano de Bergerac, Oeuvres Complètes, ed. P.L. Jacob, 2 vols., Paris, 1858, re-ed., Paris, 1962, Fragment de Physique, II, 354, "Que la physique ne peut être qu'une Science conjecturale", and II, 370, "...suivant les préceptes de l'Ecole...qui défend de faire par le plus ce qui peut se faire par le moins".

and his method was the right one for discovering new truths and avoiding error. But he stressed that the "...Improvement of Reason, together with such a Freedom and Openess of Mind, as may render it capable of judging sincerely and impartially...are incomparable more to be valued than the Knowledge of all the Sciences in the world",[13] that "...what remains yet to be done, is almost infinite..."[14] and that he should like to avail himself of the experiments and discoveries of the Académie des Sciences either to correct his principles or "...be the more strongly confirmed in the Truth of them".[15]

How did he realize his ideals? What differences and similarities were there between his theory and practice of science? The paucity of sources raises a difficulty in answering such questions. In the absence of notebooks and a number of publications spread over a period of time we have to base our arguments mostly on what Rohault wished to tell the reader of his <u>Traité de Physique</u>. In the <u>Traité</u> he made an admirable attempt to follow his prescription for the sciences. He devoted comparatively little space to a discussion of metaphysical questions and of the opinions of the Ancients. He proceeded as soon as possible to an examination of the effects and causes of particular natural phenomena. The <u>Traité</u>, however, could not have been written without its author having studied thoroughly the written works of Descartes.

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[13] Rohault, <u>System</u>, I, 35, 285.

[14] ibid., III, 17, 257.

[15] ibid., IV,26, 292.

Rohault's reasoning was mathematical in that his explanations had the appearance of being geometrically demonstrated, of being justified as necessary consequences of axiomatic principles. At the same time, his method was 'mathematical' in that he used Descartes' universal methematics of self-evident truths, the division of problems into their constituent parts for their better solution, an orderly progression from knowledge of the simplest objects to the most complex, reviews of his chains of reasoning. The shape, size and motion of matter, ordered and measured by the rules of mechanics and of geometry, was the sine qua non of his physics. But to search for Descartes' analytic geometry in the Traité is to search in vain. Rohault's physics was not the mathematical physics of Isaac Newton or Christian Huygens. He did not exploit fully the strength of the newly discovered mathematical techniques of the seventeenth century and thus left his method insufficiently precise to corroborate his theories.

Nonetheless, he was aware of the difference between the abstract world of the mathematician and the concrete world of the physicist and often gave both mathematical and physical demonstrations of the point he was trying to establish. Thus, for example, he described his theory of 'gravity'.[16] He gave two geometrical demonstrations and two examples drawn from his experience of the craft of the "Batteurs et Tireurs d'or" to show that the number of

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[16] ibid., II, 28, 94 (Huygens' experiment with Spanish wax) and II, 28, 95-6 (geometrical demonstration).

points in a given quantity of matter may be regarded as indefinite.[17] He turned his attention to 'justification' of Descartes' theories by empirical observation. The first stage of his examination of the loadstone and the rainbow, he claimed, was the amassing of experimental data. Then he posed hypotheses and tested them by deduction and experiment.

> ...I shall do here as if I were the first that had made any observation about the Load-Stone. And in the first Place I shall reckon up some of its Properties, which I shall content myself, with only assigning a probable Reason for; and after that, I shall endeavour to establish the Truth of my Conjecture, by showing that all the Consequences that can be drawn from it, agree with Experience.[18]

It could be argued that in attempting to justify his theories in this way he followed what he described at the beginning of his treatise. His experiments fit into the three categories of the preface. There are immediate sense experiences which serve particular purposes and which presumably he had not thought of using at first:[19] a ball struck by a racquet to prove that determination differs from motion,[20] the colour blindness of his right eye to show that "two Persons looking in the same Manner upon the same Object, may have very different Sensations",[21] the analogy between the motion of the

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[17] ibid., I, 9, 32-7.

[18] ibid., III, 8, 163.

[19] see Chapter VI, p. 140.

[20] Rohault, System, I, 13, 79.

[21] ibid., I, 27, 197.

parts of fire and a piece of wood moving "as quick as the torrent it swims in".[22] There are those experiments which had been planned carefully and were remembered later but where the initial result was unforeseen. It has to be inferred that these include, for example, his experiments with "larmes de verre",[23] his "experience continuelle du vuide",[24] his description of the peculiarities of dyeing cloth black[25] and the method of separating gold from silver.[26] Most important and most numerous of all, there are those experiments which confirm his reasoning and increase the probability of his hypotheses: experiments with an artificial eye made from cardboard, vellum, glass and crystal, with glass drops, tubes, globes, syringes, prisms, mirrors, magnets, iron filings and compasses, experiments "to shew the Course of the Chyle in the Body"[27] and to confirm the circulation of the blood.[28]

One of the tests of his hypotheses was their agreement with empirical observation. Early in the treatise Rohault ingenuously reinterpreted the experiments on vacua which threatened one of his so called axioms, that nothing has no properties, and the corollary of one of the very principles of his physics, that since the essence of matter was extension then "that which the Philosophers call a

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[22]ibid., III, 9, 188.

[23]ibid., I, 22, 136-9.

[24]ibid., I, 12, 72. This experiment lasted for at least fifteen years.

[25]ibid., I, 27, 228-9.

[26]ibid., I, 22, 126.

[27]ibid., IV, 21, 283.

[28]ibid., IV, 12, 264-6.

vacuum cannot possibly be".[29] He argued that his two suppositions, of the existence of a syringe with very small imperceptible pores and of particles of air so 'subtle' as to enter these pores when the syringe was stopped at the lower end and the piston drawn, were confirmed experimentally.[30] He denied that the space at the top of the glass tube in the Torricellian experiment was a vacuum. Experiments showed that light rays could pass through[31] and that, when heated, a rarefaction occurred making the mercury fall: "d'où il suit qu'il y a là une veritable matière".[32] He was not troubled by Roberval's objections to those who explained the dilation of a carp's bladder by the entry of subtle matter through the pores of the glass tube. He claimed that the bladder's swelling was the result of subtle matter agitating with great force the little gross air that remained in the bladder.[33] Wallis' experiment of mercury "very exactly cleared of all air"[34] remaining suspended in a six foot tube suggested to Rohault that subtle matter might enter through the mercury instead of the tube. But because he did not have "la commodité de faire réussir cette experience",[35] he suspended judgement.

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[29] ibid., I, 8, 27.

[30] ibid., I, 12, 57-8.

[31] ibid., I, 12, 64.

[32] Rohault, Traité, I, 12, 83.

[33] Rohault, System, I, 12, 69.

[34] ibid., I, 12, 65 note 1.

[35] Rohault, Traité, I, 12, 84.

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The strength of an hypothesis could be further assured by the principle of simplicity and the scope of its explanatory powers. This was a method which Rohault used to justify his explanation of the sun's appearances, his description of the sorts of pores in the interior earth and to decide between the hypotheses of Ptolemy, Brahe and Copernicus. An hypothesis could be judged "to be the very truth" when its explanatory powers were so great as to render incredible the possibility of another explanation. Rohault claimed that his conjectures on the magnet, light and vision and the rainbow[36] fell into this category:

> The few Suppositions which I have made in order to explain the Nature of Iron and of the Load-Stone, are nothing compared to the great Number of Properties, which I am going to deduce from them, and which are exactly confirmed by Experience...[37] I doubt not but that this Opinion [of light, transparency and opaqueness] will be esteemed a Conjecture only. But if it shall afterwards be made appear to have in it all the Marks of Truth, and that all the Properties of Light can be deduced from it: I hope that That which at first looks like a Conjecture will be then received for a very certain and manifest Truth.[38]

With hindsight, however, we can see the weaknesses in Rohault's method. Despite his claim that his three elements "necessarily follow from the Motion and the Division of the Parts of Matter which Experience obliges us to acknowledge in the Universe",[39] he did not provide experimental proof or even adequate support for his belief

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[36] Rohault, System, III, 17, 225, 241, 242, 257.

[37] ibid., III, 8, 169.

[38] ibid., I, 27, 203.

[39] ibid., I, 21, 116-7.

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[37] ibid., III, 8, 169.

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[39] ibid., I, 21, 116-7.

in a plenum and particularly, in the existence of subtle matter, an element which was so important in many of his explanations. Indeed, he admitted that subtle matter was imperceptible, that it escaped "all our senses".[40] His argument, that because the piston of a syringe could be pulled up when the lower end was stopped, experimentally confirmed the existence of subtle matter, was a fallacious one. His 'a priori', metaphysical belief in a plenum predetermined his interpretation of what happened.

Rohault's experimental tests were inadequate because his theories could not be translated into details which were either empirically or mathematically exact.[41] The empirical data which he displayed ~~was~~ were not an independent and rigorously severe test of many of his, or rather, Descartes' theories, even if ~~it was~~ they were sufficient to account for his own acceptance of those theories.[42] This is noticeable on comparing what he said of the 'vacuum' experiments in his conferences in 1660/1 with what he said in his Traité in 1671. In both cases he does not appear to be searching for new experiments but is concerned with reinterpreting existing ones to his and Descartes' advantage. Having accepted the cartesian system, Rohault, with the acolyte's fervour, was disposed to interpret his experiments in a way that met the logical requirements of the system[43]

[40] ibid., I, 21, 114.

[41] see E. Nagel, The Structure of Science, London, 1961, p. 12.

[42] see Nagel, The Structure of Science, p. 43.

[43] This is also true of the experiments which he introduces, for example, in his examination of the properties of the magnet.

and in the end rendered his theories essentially deductivist, his experiments principally illustrative. The modernity of his epistemology was more apparent than real.

Rohault's work, however, cannot be seen only in this light. In mid-seventeenth century, before Roemer's discovery of the speed of light and before Newton's Principia, his elegant synthesis of Descartes' work in physics, retaining the system and dressing it in empirical garb, was a real advance on the achievement of Greek and Renaissance science and even on, it was said,[44] Descartes' "roman de la nature". Tactfully he paid homage to what he thought was of value in the work of the Ancients, thereby enhancing the value of his own work as a vehicle for the dissemination of the 'new philosophy'. And even if his work was being surpassed by other, abler men, he himself had been optimistic in his hopes for the future progress of natural philosophy and had recognised the necessity of empirical support for a theory and the tentative nature of most scientific enquiry.

Moreover, like many of his contemporaries, he was aware of the utilitarian value of natural philosophy, utilitarian, that is, in the broadest sense. Knowledge of the causes and effects of natural phenomena and of the "right method of discovering the Truth, and avoiding Error"[45] was his foremost aim and was of value for its own

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[44] Lagrange, Les Principes de la philosophie contre les nouveaux philosophes, 2 vols., Paris, 1684, I, 30-31. Cited in P. Mouy, La Physique Cartésienne, pp. 113-4.

[45] Rohault, System, I, 35, 285.

sake. But such knowledge rendered mankind 'lords and possessors of nature' and could be used for 'the relief of man's estate'. Physics was the foundation on which medicine was built.[46] Cosmography was "of great use" in geography and navigation.[47] Mathematics had helped artisans make "...toutes ces belles découvertes, dont nous avons l'avantage de joüir aujourd'huy, et qui font toute la richesse de nos Arts, et toute la commodité de nostre vie".[48] He, personally, had learnt from artisans and worked with them, giving good advice "...soit pour la construction de leurs outils, soit pour faciliter leur travail et diminuer leur peine".[49] His conferences and mathematics lessons proclaimed his desire to impart his knowledge to others, to win converts to cartesian philosophy and to demonstrate the advantages of applied mathematics for "le commerce des hommes".[50]

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[46] ibid., preface, not pag.

[47] ibid., II, 1, 4, and II, 11, 34.

[48] Rohault, Traité, preface, not pag.

[49] Rohault, Oeuvres Posthumes, preface, not pag.

[50] loc. cit.

PART III

SCIENCE AND SOCIETY:
NATURAL PHILOSOPHERS AND CENSORSHIP

INTRODUCTION

Part III includes a discussion of the effects of 'censorship' on the practice of science in mid-seventeenth century France. It would have been interesting to extend this study of the relationship between science and society, to discover whether or not the membership of Rohault's conferences reflected the importance of natural philosophy as a means of social mobility or to explore the implications of Rohault's belief in the utilitarian value of science (was his work of any significance for political, military and administrative life, did it affect industry, trade, agriculture, belief in witchcraft and astrology?). Unfortunately, the dearth of sources has thwarted attempts to provide satisfactory answers to these questions. Nonetheless, continuing with an examination of the major influences on Rohault, we emphasize that his work and that of other natural philosophers was affected by their relationship with powerful and authoritative institutions in French society. In this way Rohault is placed in a larger historical context.

Most historians of science would agree that the internalist and externalist approaches to their subject are complementary. Recent attempts to understand the Scientific Revolution have centred on explaining why new questions were asked of the material world, which is another way of asking why the leaders of the Scientific Revolution thought the way they did. Answers to this question by historians, sociologists, psychologists, philosophers and historians of ideas would

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The historian, however, has much to contribute to the history of science. Less concerned with tracing the evolution of particular sciences than with increasing his understanding of the period or area which he is studying, he is not so inclined to divide natural philosophers into those who were right and those who were wrong. His attitude to the Scientific Revolution might be to trivialize it, study it in as much detail as the vast range of sources allow, before attempting to rebuild and write a general synthesis of the events of two hundred years or more. His appreciation of the evidence that must be unearthed and sifted, and which in turn leads him to more and more questions, ought to prevent his making hasty and ambiguous generalisations of the type 'Descartes' work was rapidly diffused throughout French society' or 'Descartes' vision captured science for almost a hundred years'. The historian is best equipped to strengthen the externalist approach by discovering and analysing the evidence which leads to an assessment of the role of scientific organisations and educational institutions, helps account for the appeal of science as a career and increases our understanding of the non-intellectual conditions which influence the spread and acceptance of particular scientific problems and theories.

In mid-seventeenth century France, in a society which saw the growing centralisation of the administrative, financial and military power of the French monarchy (often at the expense of the privileges of the aristocracy, of provincial estates, and of corporate institutions like guilds and universities), natural philosophers were noted for their belief in 'la République des Lettres' and their vindication of 'la liberté philosophique'. Descartes had written at the beginning of his Discours de la Méthode, "...la puissance de bien iuger, et distinguer le vray d'avec le faux, qui est proprement ce qu'on nomme le bon sens ou la raison, est naturellement esgale en tous les hommes".[1] The 'new philosophy' called 'all in doubt'.

In mid-century, the period which coincides with Rohault's career, the monarchy, corporate institutions and apostles of 'the new learning' came into conflict on matters which affected the practice of science. The monarchy and corporate institutions had the advantage of being able to suppress whatever in the scientific world threatened to undermine their authority and to control whatever they could use to further their own interests. The natural philosophers, in turn, partly as a response to suppression and control, exercised a third form of censorship, self-censorship. That the work of natural philosophers was not insulated from these different types of censorship can be seen from the obstruction of Théophraste Renaudot's utilitarian approach to science by the Paris Medical Faculty, from the influence of Colbert and the French government on the infant Académie des Sciences, and from the reaction of French cartesians to persecution, particularly Rohault's defence of Descartes and attempt to prevent censorship of his own *Traité*.

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[1] *O.D.*, V, 2.

CHAPTER VIII

THEOPHRASTE RENAUDOT AND CENSORSHIP

Throughout his career Théophraste Renaudot found that he was caught in a contest between the crown and privileged corporations. Protected by Richelieu, spurred on by his own ambitions he embarked on a course which brought him into headlong collision with the 'Prévôt des marchands', the printers and booksellers and catastrophically, the Medical Faculty of Paris. His career illustrates the involvement of an early practitioner of science in contemporary political affairs and a type of censorship which is easy to recognize: suppression.

Traditionally, historians[1] have described Renaudot as a disinterested, imaginative and dynamic character who struggled all his life to help the poor, who represented an open, progressive, French-speaking, empiricist school of learning only to be silenced by the machinations of a doting, over-privileged and prejudiced Medical Faculty of the University of Paris. While it would be possible to paint a less glowing picture of the man's character using evidence from the court case between himself and the Medical

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[1]see G. Gilles de la Tourette, Théophraste Renaudot, d'après des documents inédits, Paris, 1884, and A. Perrin, "Théophraste Renaudot", La Cité, XXI-XXII, 1922, pp. 1-15.

Faculty (and from the correspondence of Peiresc and Gui Patin), it is our principal concern not to praise or condemn his character but to look at the difficulties he faced in practising medicine and in promoting his public conferences.

Born of Protestant parents in the west of France, Renaudot studied and practised medicine at Montpellier and Loudun before being called to Paris in 1612 as "conseiller et medecin ordinaire du Roi". A man of many interests and inventions he organised, with the patronage and approval of Richelieu and royal authority, "Bureaux d'adresse", public conferences, a news-sheet or "Gazette", "Monts de Piété" and "consultations charitables pour les pauvres malades". He became "Commissaire Général des Pauvres" and "Maître et Intendant des Bureaux d'Adresse". The royal decrees in his favour, however, conflicted with the interests and privileges of merchants, book-sellers, and the Dean, Doctors and Regents of the Paris Medical Faculty. Renaudot's career was chequered with numerous legal battles. Throughout the 1620s he was delayed in exercising the charge, Commissaire Général des Pauvres given him by Arrêt du Conseil d'Etat in 1618, because of a long contest in the courts with the Prévôt des Marchands. It was not till 1629 that the Parlement of Paris registered the 1618 decree.[2]

In 1629 and 1630 he organised his Bureaux d'Adresse. In 1630 he published an Inventaire des adresses du Bureau de rencontre

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[2]Cited in A. Perrin, op. cit., pp. 2-3.

<u>où chacun peut donner et recevoir des avis de toutes les nécessitez et commoditez de la vie et societé humaine.</u>[3] The Bureau, Renaudot maintained, was to be useful to the public and above all, the poor: "pour faciliter leur logement, vestement, nourriture, traitement et maladie, et donner principalement de l'employ aux valides, la plus nécessaire aumosne qu'on puisse leur départir...".[4] At the same time it was a thriving business concern which served a hotch-potch of interests. Money was loaned, all sorts of merchandise, property and offices were put up for sale, employment offered, advice and information supplied on a variety of topics. It was a commercial clearing-house facilitating "le commerce des hommes". In a pamphlet entitled <u>Le Renouvellement des Bureaux d'Adresse</u> (published 1647), Renaudot listed the goods and services which the Bureau provided. Among the items catalogued, there were:

> Les machines et modelles de toutes sortes d'inventions...,[5]
>
> Les artifices, invantions, secrets et curiositez permises, trouveront ici des personnes qui les payeront en argent ou autres recompenses, mesme contenteront leurs autheurs par d'autres secrets et choses souvent plus estimées des curieux que de l'argent comptant...,[6]
>
> On y sçaura le temps et les lieux ou se font les Anatomies...,[7]
>
> On y sçaura les lieux où se trouvent les Eaux de Spa, de Pougues, de Forges, de Vie-le-Comte et autres medecinales, leurs effets et leurs prix..., [8]
>
> La science des Métaux et minéraux, dite vulgairement Alchymie, n'estant plus estimée inutile à la Médecine, comme elle estoit autrefois chez les ignorans on y aura l'adresse des cours qui se feront...[9]

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[3] T. Renaudot, <u>Inventaire des addresses...</u>, Paris, 1630. See also B.N., F. Fr. 18600 fol. 462.

[4] B.N., F. Fr. 18600 fol. 476.

[5] ibid., fol. 483.

[6] ibid., fol. 478.

The Bureau also served to publicize and disseminate 'artistic' and 'scientific' information.

By Letters Patent of March 1628 and February 1630 Renaudot was given the exclusive privilege of printing and selling news-sheets or "...Gazettes, Nouvelles et Recits de tout ce qui s'est passé et passe tant dedans que dehors le Royaume...".[10] Richelieu was fully aware of the propaganda value of the Gazettes and used them to publicize his political and military campaigns.[10a] Nonetheless, in the first half of the 1630s, because of administrative confusion and opposition on the part of other publishers and booksellers, Renaudot was constantly 'harried and hindered' in the printing and sale of these news-sheets. He overcame the opposition by appealing continually to the Conseil Privé and the Conseil d'Etat. Punishment for those who contravened the king's decrees and for the officials who failed to uphold them became increasingly severe. In answer to Renaudot's appeal (Requête civile) the Conseil d'Etat decreed on the 18th November 1631 that there must be no obstacles to the execution of his privilege. No other publisher could print or sell news-sheets

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[7] ibid., fol. 477.

[8] ibid., fol. 481.

[9] ibid., fol. 484.

[10] B.N. F.Fr. 21832 fol. 164.

[10a] see <u>Richelieu, Lettres, Instructions diplomatiques et Papiers d'Etat</u>, ed. G. d'Avenel, 8 vols., Paris, 1877, V, 51, 945; VI, 134, 176; VII, 92.

"à peine de confiscation des exemplaires et de punition corporelle"[11] and "à peine de six mil livres d'amande et de tous depens, dommages et interests".[12] On the 11th March 1633 the Syndic, Adjoints des Imprimeurs and all others were forbidden to print, sell, or hinder Renaudot in printing his Gazette or to intimidate or impede in any way "les Maistres ou Compagnons Imprimeurs que ledit Renaudot voudra choisir pour travailler en son Imprimerie".[13] On the 4th August 1634 in answer to a 'request' by Renaudot to annul all that the 'Prevost de Paris and the Lieutenant Civil' had done in contravention of the Conseil's decrees of 18th November 1631, 11th March and 14th June 1633, the King stressed that these decrees should be "executez selon leur forme et teneur";[14] Renaudot could print his Gazettes whenever and through whomsoever he wished; the Lieutenant Civil must not concern himself with the Gazettes; they were for the King and his Council. The decree of 7th November 1634 repeated the conditions of previous decrees, threatened the 'premier Huissier, Sergent ou Archer du Prevost de Paris' with losing his job or worse if he failed to recognize Renaudot and apprehend those who disobeyed the royal edicts. The guilty parties were to be led "au Fort l'Evesque ou autres prisons Royaux".[15] Finally, in February 1635, the King

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[11] B.N. F.Fr. 21832 fol. 165. See also B.N. F.Fr. 22067 fol. 92.

[12] loc. cit.

[13] B.N. F.Fr. 21832 fol. 170.

[14] ibid., fol. 168.

[15] ibid., fol. 169.

granted Renaudot a 'Privilege en forme de chartre':

> De l'advis de nostre dit Conseil et de nostre certaine science, pleine puissance et authorité Royalle: AVONS, en approuvans et confirmans nosdits Arrests; Dit declaré et ordonné, Disons, declarons et ordõnons par ces presentes signées de nostre main, Voulons et nous plaist que ledit Renaudot et ses successeurs et ayans cause, jouissent pleinement, paisiblement et perpetuellement à l'exclusion des tous autres, du pouvoir, permissiõ et PRIVILEGE de composer et faire composer, imprimer et faire imprimer en tel lieu, et par telles personnes que bon leur semblera toutes les Gazettes, Relations et Nouvelles tant d'ordinaires qu'extraordinaires, lettres, coppies ou extraicts d'icelles et autres papiers generalement quelconques contenans le récit des choses passées et avenües ou qui se passeront tant dedans que dehors le Royaume, prix-courant des marchandises, Conferences et autres impressions des dits Bureaux... et generalement toutes les choses mentionnées esdits Arrests...[16]

Another bone of contention, this time between Renaudot and the Paris Medical Faculty, was the "Consultations Charitables pour les pauvres malades". These 'consultations', clinics providing medical treatment for the poor, were held at Renaudot's house every Tuesday afternoon from two o'clock. On average, said Renaudot, fifteen or twenty doctors from 'Montpellier and other famous universities'[17] each examined twenty patients and prescribed the necessary chemical remedies.

> Plus de vingt milles personnes, pouvans tesmoigner que les avenues de mon logis sont d'ordinaire tellement occupées de ces pauvres malades, qu'ils le rendent de difficile accez à toutes autres personnes.[18]

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[16] ibid., fol. 171.

[17] B.N. F.Fr. 21740 fol. 59.

[18] ibid., fol. 48.

The 'Lettres Patentes du Roy en faveur des pauvres et particulierement des malades' of September 1640 stated that, with the establishment of Renaudot's Bureaux d'Adresse the poor had received advice and assistance free of charge, "en leurs maladies et incommoditez, par la charité des médecins, chirurgiens et apotiquaires qui s'assemblent à cette fin...".[19] Wishing to support 'this praiseworthy institution' the King granted

> ...à tous ceux qui auront quelque invention ou moyen servant au bien et soulagement des dits pauvres, tant valides et invalides, mesmement quelque remède tiré des végétaux, animaux, minéraux, par le régime du feu ou autrement, de pouvoir faire en la maison dudit Renaudot et en sa présence, et non ailleurs. Et pour cet effet avons permis audit Renaudot de tenir chez lui lesdits fourneaux, et y faire toutes sortes d'opérations chymiques servans à la médecine seulement...[20]

Naturally the Paris Medical Faculty frowned upon Renaudot's work. The Dean, Doctors and Regents were opposed to an 'institution' whose existence conflicted with their privileges and whose medical practice they found abhorrent. Renaudot had not been approved by the Paris Faculty and nor would he be approved while his chemical remedies encouraged 'empiriques et charlatans' and discredited their own use of blood-letting. In the first half of the 1640s they took legal action against Renaudot and were successful in preventing him from furthering his ambitions. It is worth noting,

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[19] see T. Renaudot, Les Consultations Charitables pour les Malades, Paris, 1640. Printed in F. Danjou and M.L. Cimber eds., Archives Curieuses de l'Histoire de France, 2e Série, Paris, 1838, VI, 253.

[20] ibid., VI, 253-4.

however, that Renaudot's 'Consultations', Mont de Piété, Bureau d'Adresse and public conferences were together the means by which he performed his duties as Commissaire des Pauvres and Intendant des Bureaux d'Adresse. To attack any one of Renaudot's schemes was to attack them all.

Historians of science have regarded Renaudot's public conferences as an early example of extra-university meetings treating 'scientific' subjects. Renaudot maintained they were the fulfilment of his Bureau d'Adresse.

> Ayant fait profession de vous faciliter toutes les necessitez et commoditez reciproques, par l'establissement de mon Bureau d'Adresse, ... mon ouvrage seroit imparfait si j'obmettoye entre ces cõmoditez celle qui se recueille de la conferẽce des esprits au dire des plus excellens autheurs, la plus excellente communication, voire la plus necessaire qui soit au monde.[21]

During the ten to twelve year period from November 1632 to 1642 or 1644, conferences were held each Monday afternoon in the "Grand' Sale du Bureau", at Renaudot's house "au grand Coq, ruë de la Calandre, pres le Palais".[22] The participants, "the thousands of honourable men who attended these conferences",[23]

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[21] Première Centurie des Questions, Paris, 1634, Preface sur les, conferences, p. 1.

[22] see Centuries des questions traités ez conferences du Bureau d'Adresse, Paris, 1634-41, and Recueil général des questions, 5 vols., Paris, 1655.

[23] see Seconde Centurie des Questions, L'ouverture des conferences, Paris, 1636, p. 1, and Réponse de Théophraste Renaudot...au libelle fait contre ses consultations charitables, Paris, 1641, p. 12.

met to express views in French on subjects decided in advance. For the sake of brevity, not of larceny, the authorities for an opinion were cited only rarely. If an opinion was reasonable it did not need the support of a famous name. Members were encouraged not to foment discord by persistently defending the views they expressed - "la médisance...est bannie".[24] An opinion once stated became "un fruit exposé à la Compagnie: de la proprieté duquel aucun ne se devoit plus piquer".[25] Thus, by presenting a succession of opinions and allowing members and the readers of the published accounts of the meetings to form their own conclusions, they hoped to avoid the 'pedantic and injurious' controversies of the schoolmen. The author of "L'Ouverture des Conferences du Bureau d'Adresse" in 1634 waxed lyrical on the success and advantages of this method:

> ...et l'assemblée tiré plus de contentement de la diversité d'avis des Conferans que s'ils eussent esté tous d'un mesme accord, comme la ressemblance de plusieurs sons ne fait point d'harmonie.[26]

Defending it against the proposal that there should be only two or three speakers for each topic, he continued in the same vein. Instead of the boredom of a lengthy address their present 'multitude of concise opinions resembled a bouquet of flowers of many different scents and colours'.[27] Moreover, there were several subjects which

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[24] Première Centurie des Questions, Paris, 1634, Preface sur les conferences, p. 2.

[25] ibid., Avis au Lecteur, not pag.

[26] Seconde Centurie des Questions, L'ouverture des conferences, Paris, 1636, p. 7.

[27] ibid., p.8.

engendered such different opinions that it was impossible to limit their number: "...nostre raison se captivant si peu qu'elle se faict tous les jours de nouveaux sentiers pour parvenir à la verité qu'elle va chercher jusqu'au delà des espaces imaginaires".[28]

Harmony and flexibility were the aims of the organisation[29] but it did have its taboos. The participants restricted the 'liberty of thought' and the 'search for truth' in their 'republic of letters' to topics other than religion and affairs of state:

> ...de peur d'irriter les esprits aisez à echauffer sur le fait de la Religion, on renvoye en Sorbonne tout ce qui la concerne. Les mysteres des affaires d'Estat tenans aussi de la nature des choses divines, desquelles ceux-là parlent le mieux qui parlent le moins, nous en faisons le renvoi au Conseil, d'où elles procédent. Tout le reste se presente ici à vous pour servir d'une spacieuse carriere à vos esprits.[30]

Till November 1636 two subjects were examined in each conference and thereafter, only one. At first, too, there was an 'hour of inventions' devoted to experiments, the communication of recent discoveries, medical remedies or reviews of books and reports presented to the body. At the end of the first conference commissioners were appointed to examine and report on a book "contenant la methode d'apprendre les disciplines liberales en jouant".[31] The other members of the conference were asked to bring to future conferences the

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[28] loc. cit.

[29] see Seconde Centurie des Questions, L'ouverture des conferences, pp. 6-8.

[30] Première Centurie des Questions, Paris, 1634, preface, p.2.

[31] ibid., pp. 8, 16.

inventions they knew would profit the public "...avec asseurance que l'honneur et le profit leur en sera conservé...".[32] We note, for example, that someone brought to the third conference a recently invented microscope which was described as "un instrument qui grossit tellement les espèces, qu'une puce y paroist de la grosseur et forme d'une souris, et les petits vers qui se trouvent dans tous les bons vinaigres, de la grosseur d'anguilles".[33]

By the thirteenth conference[34] the 'hour of inventions' had disappeared from the reports of the meetings. The onset of winter had shortened conference hours leaving no time for 'inventions'. The practice was never really taken up again, even though several members continued with a similar type of work, at least during the summer of 1634. In November 1634 Renaudot reported that the vacation had been spent in proposing and examining "divers secrets et curiositez de quelques arts et sciences".[35] He gave a long catalogue of the propositions examined. But apart from the unsatisfactory statement that most of them had been found to be true and a sceptical reminder that the Bureau could not guarantee them any more than a postman could his letters, he gave no other details of the summer's work. The problems posed reflect the naïvety, superstition, enthusiasm and utilitarian bias of the conference members:

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[32] ibid., p.8.

[33] ibid., p. 24.

[34] ibid., 14 Nov. 1633, p. 108.

[35] Seconde Centurie des Questions, L'ouverture des conferences, Paris, 1636, p. 2.

Proposition XVI	Montrer et faire faire en une seule leçon les vrayes proportions du corps humain, aussi exactement qu'a fait Albert.[36]
XXIX	Perser à l'instant une porte avec une chandelle non allumée.[37]
XXXI	Faire promptement quantité d'eau douce en pleine mer.[38]
XLIV	Furent proposez presques infinis secrets pour la conservation de la santé et guérison des malades, desquelles je vous réserve la déduction plus particuliere apres que les experiences en auront esté faites.[39]

The subjects treated in conferences were so numerous that they may be described as 'scientific' only if science is synonymous with knowledge. As Renaudot said, everything, outside of theology and affairs of state, was their subject: philosophy, languages, education, political and social economy, medicine, astronomy, physics, meteorology, geology, ethics, the curious, the occult, the utilitarian and the philanthropic. Subjects which were neglected included mathematics, history, geography, literature and mechanics, whereas among those most often treated were medicine, physics and what can be described as a dilettante mixture of morals, manners and the curious. The members enjoyed discussing such subjects as beauty,[40]

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[36] ibid., p. 4.

[37] ibid., p. 5.

[38] loc. cit.

[39] ibid., p. 6.

[40] Première Centurie des Questions, Paris, 1634, conference 26(2).

friendship,[41] anger,[42] chastity,[43] what makes a man wise,[44] must a son obey his father,[45] is country life better than town life,[46] is it better to be married or not.[47] Just as the variety of subjects reflected the diversity of members' interests so within individual conferences there was a difference of arguments and attitudes. Some, for example, made use of the opinions of the Ancients and the schoolmen, others the mysticism and superstition of the Paracelsians and cabbalists.

TABLE III - Conferences at the Bureau d'Adresse[48]

Subject	Conference Number	Title
Languages	42(1)	De la diversité des langues
	76(2)	Des hieroglyphes
Philosophy	1	De la méthode De l'Estre
Education	106(2)	S'il est expedient aux femmes d'estre sçavantes
	191	Lequel est le plus propre à l'estude, le soir ou le matin
	285	De la conférence, et si c'est la plus instructive sorte d'enseigner

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41 ibid., conference 38(2).

42 Seconde Centurie des Questions, Paris, 1636, conference 68(2).

43 ibid., conference, 71(2).

44 Première Centurie des Questions, conference 9(2).

45 Quatriesme Centurie des Questions, Paris, 1641, conference 277.

46 Troisiesme Centurie des Questions, Paris, 1639, conference 108(2).

47 ibid., conference 141.

48 from Première[-Quatriesme] Centurie des Questions, Paris, 1634-41.

TABLE III (cont.)

Subject	Conference Number	Title
Political and Social Economy	160	Le commerce déroge-il à la noblesse?
	286	Quelle science est la plus nécessaire à un Estat?
	178 seq.	Resultat des assemblées tenues dans le Bureau d'Adresse durant les vacatĩos de la presente année 1638 touchant les moyens de restablir le cõmerce.
Medicine	38(1)	Du circuit ou accez des fiévres
	98(1)	Des causes de la contagion
	105(1)	De la saignée
	107(1)	S'il est bon de se servir de remédes chimiques
Astronomy	10(1)	Du mouvement, ou repos de la Terre
	93(1)	Des taches de la Lune et du Soleil
	94(1)	Des eclipses du Soleil et de la Lune
Physics	46(1)	Du vuide
	51(2)	Pourquoi l'aimant attire le fer
	97(1)	Des poids et des causes de la pesanteur
Meteorology	18(1)	De l'origine des vents
	72(2)	Du tonnerre
Geology	109(1)	Des volcans
	136	De l'origine des pierres précieuses
Ethics	33(2)	Quelle est la plus excellente des vertus morales?
	268	S'il faut faire du bien à tous
Curiosities	10(2)	Des deux freres monstrueux vivans en un mesme corps, qui se voyent en cette ville de Paris
	229	Du Buveur d'eau de la foire S. Germain

TABLE III (cont.)

Alchemy and the Occult	37(1)	De la cabbale
	43(1)	De la pierre philosophale
	173	Des amuletes...
	221	De l'astrologie judiciaire
Philanthropy	35(2)	Du Réglement des Pauvres
	43(2)	Du Mont de Piété

What purpose did the conferences have? Were they a centre for 'scientific' research, a representative of a new and progressive learning, an extension of the Bureau d'Adresse or a sorting-house of ideas and discoveries for the education of a small élite? Undoubtedly they were all of these. Yet we may question the value of their scientific research which seems to have been haphazard, badly organised and given to an excessive belief in the curative powers of all sorts of chemical and alchemical recipes. Not surprisingly, no major discovery emerged from the conferences.

Certain members, including Renaudot, regarded the educational method of the conference as superior to that of the schools. Renaudot proclaimed the right of conference members to advance opinions contrary to those of the schoolmen. Otherwise, he said, "la liberté de nostre raisonnement"[49] and "la recherche de la verité"[50] would be meaningless "s'il demeuroit entièrement captivé sous la férule d'une

[49] Première Centurie des Questions, Avis au Lecteur, not pag.

[50] loc. cit.

authorité magistrale".[51] In a meeting held on the 4th March 1641, 'On the conference, and if it is the most instructive teaching method', the fourth and final speaker argued that "...si l'homme est bien dit un animal sociable, l'ame estant sa meilleure partie, son instruction ne se peut mieux faire que par la conférence, qui est le commerce des ames";[52] that the conferences had discovered several great minds who formerly were hidden and buried in the dust of the schools; and that instead of the "Incapacité qui provient de la rudesse des termes de l'Escole et de l'humeur opiniâtre que les Escoliers contractent ordinairement par la dispute"[53] the conferences taught a young man how to behave in company and prepared him for court and 'other places where he ought to appear'. Moreover, it is clear from the catalogue of inventions examined in 1634 that one aspect of the assembly's work was to inspect and accredit new educational techniques.[54] At the same time, however, no one suggested that the University of Paris should be abolished. Renaudot admitted that respect was due to the "infinity of learned persons who painstakingly cultivated reason in their schools".[55]

As we have noted, Renaudot claimed that the conferences were primarily an integral part of his Bureau d'Adresse. They were a

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[51] loc. cit.

[52] Quatriesme Centurie des Questions, p. 420.

[53] loc. cit.

[54] see Seconde Centurie des Questions, L'ouverture des conferences, p. 4, propositions XXVI, XXVII, XX, XXV.

[55] Première Centurie des Questions, preface, p. 1.

market for the exchange and communication of ideas and discoveries. His sole preoccupation, Renaudot said, was with providing what was useful to the public, an opportunity for harmonious and enjoyable discussions. The conference was "un aimable concert et rapport de plusieurs avis, par la diversité desquels l'auditeur forme le sien... Le jeune s'y façonne, le vieil y raffraischist sa memoire, le docte s'y fait admirer, les autres y appressent, et tous y rencontrẽt un divertissement honneste".[56] The tournament of the conferences was an honourable one. Science was the prize, Paris the jousting place and France, indeed, all the world, was the judge of their value.

Despite Renaudot's praise for the conferences, lack of evidence forbids our describing accurately the width of their social base or the effectiveness of their appeal. Their regulations ensured the anonymity of members. They were sufficiently effective, however, to warrant the disdain of Dupuy, Peiresc, Tallemant des Réaux, Furetière, and the Paris Medical Faculty. Tallemant, for example, in one of his Historiettes wrote disparagingly of La Calprenède and the conferences: "...quoy'qu'il fut l'homme de condition, il fut longtemps un des arcs-boutons du bureau d'adresses, et ne manquoit pas une conference".[57] The Gazette of 1 Avril 1634 tells us that Jean Baptiste Morin presented to the assembly his scheme for measuring longitudes at sea before it was examined and rejected by

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[56] ibid., p. 2.

[57] Tallemant des Reaux, Historiettes, ed. A. Adam, Dijon, 1960, p. 584.

commissioners appointed by Richelieu. Renaudot and his son Eusèbe enlarged the audience of the conferences by publishing weekly reports and volumes of questions treated in conference and selling them throughout France and 'the universe'. From the number of editions of the Centuries des Questions which appeared between 1634 and 1670 it would appear that they were widely diffused and enjoyed a considerable degree of popularity.[58]

The conferences had forestalled censorship by the crown by refusing to debate political and religious affairs. But the biggest threat to their continuation and to Renaudot's practice of medicine came from the Paris Medical Faculty and the support it eventually obtained from the king's council, the courts of the Châtelet and the Parlement of Paris. Between 1640 and 1644 Renaudot became involved in yet another prolonged defence of his privileges.

The legal battle between Renaudot and the Medical Faculty is well documented. During the court-trial both parties engaged in

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[58] Première Centurie des Questions, Paris, 1634, 1635, 1636, 1638.
Seconde Centurie des Questions, Paris, 1636.
Troisiesme Centurie des Questions, Paris, 1639, 1641.
Quatriesme Centurie des Questions, Paris, 1641.

Recueil Général des Questions, 4 vols. in 8°, chez J. Promé, Paris, 1655, 5th vol. in 8°, chez J. Promé, Paris, 1660.
Cinquiesme et dernier tome du Recueil Général...non encore mises au jour, chez V^ve G. Loyson, Paris, 1655.
Recueil Général des Questions, éd., corrigée et augmentée, 5 vols. in 8°, chez L. Chamhoudry, Paris, 1655-6.
Recueil Général des Questions, 6 vols. in 12°, chez A. Valançoi, Lyon, 1666, 7th vol. in 12°, Paris, 1670.
Recueil Général des Questions, 6 vols. in 12°, Paris, 1666.
A General Collection of the Discourses of the Virtuosi of France..., trans. G. Havers, London, 1664. Another Collection of Philosophical Conferences of the French Virtuosi..., trans. G. Havers and J. Davies, London, 1665.
This list does not include the reprints of individual questions such as, A Question, Whether there be nothing new, trans. into English for J. Emery, London, 1640.

a vicious pamphlet warfare in presenting their case to the public. The Factum du Procès entre Renaudot et les Medecins de Paris defendens[59] was followed in 1641 by René Moreau's La Defense de la Faculté de medecine contre son calomniateur.[60] Renaudot replied with La Réponse de Théophraste Renaudot medecin de Montpellier au libelle fait contre ses Consultations Charitables.[61] Jean Riolan (or Gui Patin) thrust again with the Avertissement à Théophraste Renaudot contenant les Mémoires pour justifier les Anciens droicts et privileges de la Faculté de Medecine de Paris,[62] only to have Renaudot parry with Remarques sur l'Avertissement portées à son auteur par Maschurat.[63] Renaudot was as yet protected by Cardinal Richelieu.[64] But when Richelieu died in 1642 Renaudot's position became tenuous. In 1643 he boldly presented a Requeste à la Reine[65] for land and a hospital for his 'consultations charitables'. René Moreau attacked with the

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[59] no place, 1641.

[60] Paris, 1641.

[61] Paris, 1641.

[62] Paris, 1641.

[63] Paris, 1641.

[64] see Lettres de Gui Patin, ed. J.H. Reveillé-Parise, 3 vols., Paris, 1846, Patin à Belin, 15 Mai 1641, I, 77-8. "Si ce gazetier n'étoit soutenu de l'Eminence...nous lui ferions un procès criminel, au bout duquel il y auroit un tombereau, un bourreau, et tout au moins une amende honorable...".

[65] Requeste présentée à la Reyne par Théophraste Renaudot, en faveur des pauvres malades de ce royaume, no place, no date.

Examen de la Requeste presentée à la Reine le 4 novembre 1643 par le Gazettier.[66] Renaudot counter-attacked with the Réponse à l'Examen de la Requeste presentée à la Reine par Théophraste Renaudot. Portée à son autheur Machurat.[67] By this time the case in the courts was nearing completion. In October 1641, the Faculty had appealed against Renaudot's 'consultations charitables' in the courts of the Châtelet, but Renaudot had prevented condemnation by obtaining an Arrest d'Evocation au Conseil Privé du Roy. When Richelieu died, the Faculty moved more vigorously against Renaudot. On the 9th June 1643 they presented a supplication to the King and Council. The 7th August the Council decreed in their favour and sent the case to the Provost of Paris. On the 9th December the Provost confirmed the decree and condemned Renaudot on all points. In January and February 1644 Renaudot appealed to the courts of the Parlement of Paris. Supporting the appeal were his sons Isaac and Eusèbe, the Doctors of the Medical Faculty of Montpellier and a number of poor people of Paris, bourgeois and members of the nobility: "Maistre Gilles Auvray Prestre,...Laurent Oger...Thomas Piret... Jacques Chevalier, Jacques Beillard, ...Maistre François de l'Hospital Mareschal de France, les Comte et Comtesse de Castres...".[68] At the end of February the Court heard the case of the various parties and on the 1st of March, upholding the decision of the Provost of Paris,

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[66] no place, 1643.

[67] Paris, 1644. See B.N. F.Fr. 21740 fols. 42-79.

[68] B.N. F.Fr. 17324, Extrait des Registres de la Cour de Parlement, fols. 203-4.

"... a mis et met l'appellation au néant...".[69]

The affair is remarkable for the number of issues involved. The basic issue between the contestants concerned the legality of Renaudot's Letters Patent. The Medical Faculty denied this legality on the grounds that their own privileges were older, more numerous and hence took precedence over those of Renaudot. According to articles fifty-one and fifty-nine of the 1598 Statutes and article fifteen of the 1600 Statutes, all of which were renewals of former ordinances of Charles V, a doctor had to be of the Paris Faculty, "ou agregé, ou Privilegié"[70] before he could practice medicine in Paris. Renaudot had received his degree from Montpellier and therefore was not entitled to practice medicine in Paris: "la Faculté de Montpellier ne voudroit pas souffrir pratiquer les Docteurs Regens de Paris; pourquoy donc la Faculté seroit-elle obligée de les souffrir à Paris?".[71]

The Faculty focussed their attack on Renaudot's "consultations pour les pauvres malades". This, however, involved not only Renaudot's claim to practice medicine but the 'chemical' methods he employed, his request for a hospital and the support he obtained from Doctors of Montpellier, Surgeons and Apothecaries of Paris.

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[69] ibid., fol. 218. See also B.N. F.Fr. 15593 fols. 581-603 and F.Fr. 18600 fols. 504-7. The Arrest de la Cour de Parlement, pour les Doyen et Docteurs Regens de la Faculté de Medecine de Paris was printed by C. Morlot, Paris, 1644.

[70] B.N. F.Fr. 15993 fol. 589. See also B.N. F.Fr. 17324 fols. 205-10. Article 59 of the 1598 Statutes begins "Nullus Lutetiae faciat nisi in hac Medicorũ schola Licentiã aut Doctoratũ sit assectus etc".

[71] B.N. F.Fr. 15993 fol. 586.

The Faculty insisted that their own method made as little use as possible of the chemical remedies of 'apothecaries, spagyrites and Paracelsists'. Gui Patin, for example, a virulent opponent of antimony, described the work of apothecaries as "...leur bézoard et les autres forfanteries de leurs boutiques"[72] and the chemical remedies of Montpellierites as "C'est de la forfanterie qui vient des Arabes, et que nous avons heureusement chassée de deçà".[73] It was not till the eighteenth century that Surgeons and Apothecaries were recognised as members of independent and respectable professions.

The pamphleteers waged their paper warfare on an even larger battleground. Often using bitter, personal and puerile arguments they lashed out at each other with whatever historical, religious or defamatory evidence they could find.

For the most part, Renaudot was content with defending himself and his work. When he saw that attack was the best form of defence he used a mixture of biting satire, bitter sarcasm and angry indignation to strike at his opponent. He described the author of the Examen de la Requeste... as a "meschant et detestable prevaricateur"[74] who went so far as to use "des termes de gibet et de plusieurs autres qui ne peuvent sortir que d'un furieux".[75] He chided his critics

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[72] Lettres de Gui Patin, ed. J.H. Reveillé-Parise, Patin à C. Spon, 8 Mars 1644, I, 323.

[73] Lettres de Gui Patin, nouv. édit., ed. P. Triaire, Paris, 1907, Patin à C. Spon, 6 Dec. 1644, I, 442-3.

[74] B.N. F.Fr. 21740, Réponse à l'Examen de la Requeste..., Paris, 1644, fol. 54/ p. 25.

[75] ibid., fol. 55/p. 28.

for their lack of charity and lack of disinterest.[76] He recited the parable of the good Samaritan, allegorically representing the Doctors in medicine of other Faculties as the Samaritan and the Doctors of the Paris Faculty as Those who pass the poor man on the other side of the road.[77] His own clinics, which his opponents wished to suppress, "n'avoient autre motif que celuy d'une charité reglée, pour le bien et l'utilité des pauvres".[78] The practice of the Montpellierites, Renaudot maintained, was superior to that of the Parisians. Instead of Greek and Latin phrases, repeated bathings and blood-letting, the doctors at his clinics worked in harmony with the Master Surgeons and Apothecaries of Paris often prescribing successful chemical remedies for patients who had been maltreated by Doctors of the Paris Faculty. He gave the names, addresses and case histories of patients who either were mistreated by Paris Doctors and timely rescued by the interference of Doctors from his Bureau or who had lost so much blood from faulty diagnosis and treatment by Paris Doctors that nothing could be done for them.[79] The work of Paris Doctors, he said, was marred by "les brigues et factions perpetuelles qui les divisent".[80] Their lessons were insipid; their methods mocked the credulity of the sick. They envied the

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[76]ibid., fol. 46/p. 11.

[77]Réponse de Théophraste Renaudot...au libelle fait contre ses Consultations Charitables, Paris, 1641, p. 89(?).

[78]stated by Bataille, Renaudot's lawyer. B.N. F.Fr.17324 fol.210/p.18.

[79]B.N. F.Fr. 21740 fols. 58-66/pp. 32-49.

[80]ibid., fol. 59/p. 34.

reputation of the Master Surgeons of Paris and by their neglect and attempt to discredit the Apothecaries of Paris, they had reduced pharmacy to a pitiful state. And now they demanded what Martian and his companions demanded in Rome against Galen - "assavoir que cet Art libre de la Médecine, soit enchainé et rendu non seulement captif sous leurs loix, mais qu'il soit défendu à tous les autres de l'exercer dans ce petit monde de Paris, non pas mesmes pour les pauvres".[81]

The Faculty's spokesmen attacked Renaudot on an even greater number of counts. Renaudot was described as an ignorant charlatan, "...un fanfaron et un ardelio".[82] "Le Maistre des Gazettes (il ne faut pas salir le papier de son nom qui sera odieux et exécrable à la postérité)...",[83] wrote the author of the Examen de la Requeste... The printed reports of his Monday conferences were "une panspermie d'ignorances et d'erreurs".[84] His Bureaux, Consultations and Mont de Piété were a fraud. Instead of helping the needy he charged such extortionate rates of interest on his loans that he brought his customers to their ruin.[85] The Faculty was incensed by what they called the vulgarity and indignity of Renaudot's schemes. The

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[81] ibid., fol. 75/p. 67.

[82] Lettres de Gui Patin, ed. J.H. Reveillé-Parisse, Patin à Bélin, 9 Juin 1644, I, 112-3.

[83] B.N. F.Fr. 21740 fol. 44/p. 6.

[84] La Defense de la faculté de Medecine..., Paris, 1641, page 8.

[85] B.N. F.Fr. 17324 fol. 209/p. 16.

author of La Defense... admitted that Renaudot's sons were refused the bonnet in order to punish their father and his "...trafic et negotiation à vendre des Gazettes, à enregistrer des valets, des terres, des maisons, des hardes de Malades, à exercer une Fripperie, prester agent sur gages, et autres choses indignes de la dignité et de l'employ d'un Medecin".[86] Chenvot, the Faculty's lawyer, made the point "Si l'appellent vouloit faire des charitez, c'est en particulier, et non pas en public, les imprimer ny afficher par les rues".[87] Renaudot was charged with attempting to make himself the author of a new sect, the Dean of a new Medical School. He wanted, "...en un mot, pervertir tous les ordres du Royaume, ruïner tout l'estat de la Police, oster tous les privileges, et donner la liberté à tout le monde...c'est à dire rendre toutes choses communes, et introduire l'heresie des Anabaptistes...".[88]

At a cynical but realistic level of interpretation, Renaudot lost his case because, with Richelieu and Louis XIII dead, he lost the protection of the Conseil d'Etat. There existed, nonetheless, a reason for the Court's decision. The Parlement of Paris chose to uphold the ancient privileges of the University of Paris on the grounds that they were part of the established, corporate structure of society. At least, it was this argument that Omer Talon, the Procureur Général, emphasized in his classic summing up of the case.

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[86] La Defense de la faculté de Medecine..., Paris, 1641, pp. 16-17.

[87] B.N. F.Fr. 17324 fol. 210/p. 17.

[88] ibid., fol. 204/p. 6, and La Defense de la faculté de Medecine, Paris, 1641, p. 53.

> Les Universitez fameuses et approuvées nourrissent des Escoliers, les instituent dans les bonnes Lettres, les reçoivent aux degrez, leur donnent des Lettres de Bacheliers, de Licence et de Doctorat, qui sont des marques de suffisance acquise; Aprés lesquelles ils en peuvent faire les fonctions. Les Arts Liberaux et méchaniques, l'exercice des Marchands sont reduits en Corps et en Communauté, qui seuls non seulement peuvent avoir employ public dans les Villes Jurées; mais mesme ont droit prohibitif d'empescher ceux qui ne sont pas de leurs Corps, d'entreprendre sur leurs fonctions: quelque suffisance qu'ayent des Estrangers, elle est Suspecte, quand elle n'est pas approuvée; ... Si un artisan ne peut tenir boutique, qu'il ne soit receu maistre dans la ville de Paris; si la Faculté de Montpellier n'admet pas les Medecins de Paris, qu'apres une connoissance exacte; et que dans toutes les villes du Royaume, nul ne puisse exercer la Medecine, qu'il ne soit approuvé par le Magistrat, et aggrée par les autres Medecine; ...doit on souffrir que les Medecins d'une Faculté Estrangere, exercent publiquement?[89]

Renaudot's projects proved too radical for the Medical Faculty and Parlement of Paris. Parlement fined him "en l'amende et aux depens",[90] ordered him to surrender his Letters Patent "pour l'establissemẽt du Bureau et permission de vendre à grace"[91] and to allow the officers of the Châtelet into his house "pour faire inventaire de toutes les hardes qui se trouveront en sa maison, pour les rendre et les distribuer à qui il appartiendra".[92] 'Renaudot, his adherents and associates who were not Doctors of the Paris Faculty were forbidden to practice medicine, or to hold any conference, clinic or assembly in the Bureau d'Adresse or anywhere

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[89]B.N. F.Fr. 15593 fols. 596, 599/pp. 91, 97.

[90]B.N. F.Fr. 17324 fol. 218/p. 33.

[91]loc. cit.

[92]loc. cit.

else in the town and environs of Paris or to treat or dress the wounds of anyone under any pretext whatsoever.'[93]

Renaudot's contest with the Paris Faculty was significant not only because it pointed to the pitfalls which existed for natural philosophers in mid-seventeenth century France but also because it led to an outright condemnation of his work by the Parlement of Paris. As a result of the legal battle Renaudot could no longer act as Commissaire Général des Pauvres and Intendant des Bureaux d'Adresse, the means by which he had displayed his remarkable, if somewhat crude, talents as an organiser and publicist of the 'new science'. We now turn to examine a more subtle and less public type of influence which affected the independence of the scientific community; that which Colbert and the French government exercised on the Académie des Sciences.

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[93]ibid., fol. 203/p. 3. The court sustained the decision of the Provost of Paris of 9 Dec. 1643. There is no evidence to show that the conferences and clinics continued after 1644. In 1647 the Bureau d'Adresse was reopened, but only temporarily. With the coming of the Frondes Renaudot followed Mazarin to St. Germain.

CHAPTER IX

COLBERT AND THE INFANT ACADEMIE DES SCIENCES

The events which led to the foundation of the Académie des Sciences are not precisely known. The absence of official documents has meant that the accounts of many historians have remained incomplete and hypothetical. Some, like Fontenelle, explained the foundation in terms of 'scientific' progress: "...le renouvellement de la vraye Philosophie a rendu les Académies de Mathématiques et de Phisique si necessaires....".[1] Others, like Charles Perrault, emphasized Colbert's interest in the sciences and desire to glorify the name of Louis XIV: "M. Colbert...était persuadé que les sciences et les beaux arts ne contribuent pas moins à la gloire d'un règne que les armes et toutes les vertus militaires...".[2] A sketch of the reasons for the foundation can be divided into two parts. There are circumstances which are of secondary importance: the leisured and respectable vogue for conferences and academies which existed throughout Paris, France and Europe as a whole, political stability, rivalry with the English and the Italians, the values of the age. Of primary importance are the initiative of Colbert and the pleas for royal patronage from certain natural philosophers and their propagandists in Paris.

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[1] B.B. de Fontenelle, Histoire de l'Académie Royale des Sciences, Paris, 1733, I, 5.

[2] Ch. Perrault, Mémoires de ma vie, ed. P. Bonnefon, Paris, 1909, p. 219.

The appeal for royal patronage from conferences which dealt almost exclusively with natural philosophy makes obvious the link between a flourishing conference milieu and the Academy's foundation. The influence of this milieu, however, goes even deeper. It nurtured and directed newly-fledged and aspiring natural philosophers. It helped make science fashionable and, in so doing, prepared public opinion for the Academy's foundation.

In France, conferences had been encouraged by a comparatively long period of political stability. Success abroad supposedly provided the opportunity for the institution of a royal academy. Fontenelle wrote, "...après que la Paix des Pirénées eut été concluë, le Roi jugea que son Royaume, fortifié par les conquetes qui venoient de lui être assurées, n'avoit plus besoin que d'être embelli par les Arts et par les Sciences...".[3]

French propagandists appealed to Louis XIV to surpass the praiseworthy example set by Charles II of England and Prince Leopold of Tuscany. Early in 1665, Adrien Auzout voiced his hopes for royal protection of "La Compagnie des Sciences et des Arts"[4]

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[3] Fontenelle, loc cit. See also J.B. Duhamel, Regiae Scientiarum Academiae Historia, Paris, 1698, p. 1. In the Archives Nationales, there is an Extrait des Registres du Conseil d'etat du 21 Mars, 1661, which begins: "Le Roy voulant que les Arts qui ont esté negligez pendant la guerre, et particulierement ceux qui sont considerables dans L'Etat, soient curieusement exercez à present que la France est dans le repos, et qu'elle joüit des douceurs de la Paix;" (A.N. ADVIII 5.)

[4] This would appear to be the group which met at the house of Melchisédech Thevenot after Montmor's academy had disbanded in June 1664. See B.N. Clairambaut fols. 258-64.

and its scheme for an observatory:

> ...afin que s'il arrive d'autres fois, des choses nouvelles à observer dans le Ciel, les François ne cedent pas en cela aux Estrangers, puisque Vostre Majesté n'entend pas qu'ils leur cedent en toute autre chose, et qu'ils puissent contribuer comme les autres Nations, par des Observations les plus exactes qu'on puisse souhaiter, à determiner ce que la curiosité des sçavans leur fait rechercher depuis si longtemps.[5]

The foundation of the Academy may be seen, generally, as one expression of the values of the age; part of an absolutist theory of government where the monarchy sought to exercise control over all forms of learning, a cog in a bureaucratic machine turning the wheels of mercantilist economic expansion, a product of a classical spirit of aesthetics. This view is a common one among twentieth century historians. A.J. George,[6] for example, used it to explain the persistence of Colbert's plans. He saw the foundation of royal academies in general, from the Académie Française in 1635 to the Académie de Musique in 1672, as the policy of an absolute ruler seeking "...to direct the intellectual and artistic endeavour of the nation...into compliance with the royal ideas of excellence in all genres".[7] He saw the foundation of the Académie des Sciences as an integral part of Colbert's economic policy. "...Colbert understood that he needed aid from science to advance the 'arts et métiers' and to raise the productive level of national manufacturers."[8]

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[5] A. Auzout, <u>L'Ephémeride du Comète</u>, Paris, 1665, Epistre au Roy, not pag.

[6] A.J. George, "The Genesis of the Académie des Sciences", <u>Annals of Science</u>, III, 1938, pp. 372-401.

[7] ibid., p. 387.

[8] ibid., p. 388.

Undoubtedly the increase in royal power and the attack on privileged corporations that went with it, contributed to the foundation of royal academies. To suggest, however, that either Louis or Colbert dictated a detailed plan of work to the Académie des Sciences is a mistake. The evidence of letters, histories and the Academy's 'Registres'[9] shows that Colbert, while expecting results and showing a lively interest in the early Academy, neither interfered nor 'regimented' to the degree which George's suggestions imply.

This criticism does not deny that Colbert, in founding the Academy, consciously or unconsciously attempted to realize an absolutist, mercantilist or classical ideal. The circumstances of the foundation, however, can be stated in simpler and more direct terms. As Perrault said, an interest in the sciences and a desire to glorify the king weighed most in Colbert's mind. Colbert, as Surintendant des Bâtiments du Roi, built a visibly striking monument to the glory of Louis XIV. In this respect, the foundation of the Académie des Sciences might be classed with the building of Versailles, the Louvre, the Observatoire, the Invalides, the Gobelins and the Savonnerie, the expansion of the Bibliothèque du Roi and the Cabinet des Medailles et des Estampes, or the establishment of the Ecole des Langues Orientales and a chair of anatomy in the Jardin des Plantes.

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[9] Archives de l'Académie des Sciences. The first six volumes of the 'Procès-Verbaux' or 'Registres de Physique et de Mathematiques' cover the years 1667 to 1669. No Registres are available for the years 1670 to 1674.

Whatever the reasons for Colbert's interest, much of the responsibility for the Academy was his. Only his decision to answer the appeals of Paris savants and to continue his interest and financial support after its foundation, made its official status a reality. His Lettres, Instructions et Mémoires[10] and the 'Procès-Verbaux'[11] of the Academy bear witness to his continued interest, the Comptes des Bâtiments du Roi[12] to his financial support.

On the other hand, Colbert's decision was strongly influenced by the demands of French savants. Many, especially those who met at the house of H.L.H. de Monmort and later at Melchisédech Thevenot's, felt that conferences and private academies lacked the funds, space and opportunity for a serious and continuing experimental study of nature. In 1663, Samuel Sorbière stressed that Montmor's assembly was not the place to build "un Arsenal de Machines a faire toute sorte d'experiences".[13] Thevenot lamented that his personal fortune was not large enough to maintain "la dépense des expériences".[14] In October 1664, members of the

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[10] Lettres, Instructions et Mémoires de Colbert, ed. P. Clément, 7 vols., Paris, 1861-82, especially volume 5.

[11] or Registres.

[12] Comptes des Bâtiments du Roi sous le règne de Louis XIV, ed. J. Guiffrey, 5 vols. Paris, 1881-1901, especially volume 1.

[13] G. Bigourdan, Réunions savantes, p. 217.

[14] Bibliotheca Thevenotiana sive Catalogus impressorum et manuscriptorum Librorum Bibliothecae viri Clarissimi D. Melchisedecis Thevenot, Paris, 1694, Avertissement, not pag.

Compagnie des Sciences et des Arts at Thevenot's, submitted to Colbert through François Hotman their enthusiastic plan for the 'perfection of the Arts and Sciences and all that might be useful to mankind', which was to be achieved 'by experiment and discoveries in the Heavens and on Earth'.[15] On January 2nd, 1665, Auzout used his observations on the 1664 comet to publicize his own work and to appeal to the king for an observatory and support for the programme of the 'Company'. All of these propagandists saw that their demands could be met only by government support. Their appeals to Louis XIV, Colbert and public opinion helped create an atmosphere in which a royal academy financed by the state was deemed a necessity.

Due to administrative delays and problems over what form the Academy was to take, the mathematics group, comprising Auzout, Roberval, Frenicle, Picard, Huygens, Carcavi and Buot, did not meet till late in the spring of 1666.[16] On June 8th, Henry Oldenburg told Robert Boyle of the "choyce persons yt are to constitute" the French Academy. They were, he said,

> ...all very able men, appointed to meet and consider of ye best way of framing a Philosophicall Society, and ye best method of carrying on its dessein. I perceave, they will chiefly poursue Mechanicall and Chymicall Experiments, they having already in their Eye a couple of good Chymists, and some able Mechanitians, yt shall worke by their directions. "On fera faire (saith my Author) tout ce qu'il faudra pour travailler utilement. on a desia commencé de s'assembler pour faire quelques reglemens."[17]

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[15] B.N. Clairambaut fols. 258^{ro} and 264^{ro}; O.H., IV, 325.

[16] see Registres, II, fols. 1-5.

[17] The Correspondence of Henry Oldenburg, ed. and trans. A.R. and M.B. Hall, III, 154.

On October 13th Oldenburg received word from Henri Justel that Cureau de la Chambre, Claude Perrault, du Clos and Gayant had been chosen for the Academy.[18] By December 1666, the day of the first joint meeting in the king's library, the names of Mariotte, Pecquet, Bourdelin and Marchand had been added to the group of physicists, J.B. Duhamel had been chosen as secretary and the assembly supplemented by five 'eleves' or assistants - La Voye, Niquet, Pivert, Richer and Couplet.[19]

The survival and success of the newly formed Academy depended on a number of things. Its members had to produce results which demonstrated that they really were the élite of the French scientific community. This could only be achieved if there was cooperation between the members, communication with other academies and savants, and an organisation which allowed the maximum of flexibility. But most important of all, the infant Academy owed its very existence to the continued financial support of Colbert and the French government.

Not much is known of the organisation of the early Academy. Nonetheless, from the Procès-Verbaux it can be described as adaptable and informal. There was a President who acted as official spokesman and chairman of the assembled body, and a Secretary who looked after correspondence and kept a record of the Academy's proceedings.

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[18] ibid., III, 240-1.

[19] see Membres et Correspondants de l'Académie des Sciences 1666-1954, Paris, 1954.

Carcavi became President on the 15th of January 1667.

> La Compagnie a prié M. de Carcavy de prendre les voix, d'arrester les contestations s'il y en avoit, et d'empescher qu'on ne parle d'autre chose que du sujet qui aura esté proposé.[20]

At first it was he who corresponded with Henry Oldenburg, Secretary of the English Royal Society.[21] Later, the task fell to Jean Gallois who replaced J.B. Duhamel as Secretary of the French Academy in April 1668.[22] Gallois, like Duhamel before him, was responsible for the 'Registres'. The Registres do not always give a full account of the Academy's work. Sometimes there is only a passing reference to what had been done, and often their account is a copy of a written report submitted by the member responsible for the task undertaken.

The members, as their annuities suggest, were not equal in importance. In practice, this inequality was reflected in the tasks to which they were appointed. Most of the menial work, the preparation and demonstration of experiments, was done by the 'eleves'. Most of the experiments that Bourdelin performed were

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[20] Registres, I, fol. 200.

[21] 8 February 1668/18th Feb. N.S., Carcavi wrote to Oldenburg:

> ...et come vos travaux et les nostres ne tendent qu'a l'utilité publique, et que le secours mutuel que nous pourrions nous rendre serviroit beaucoup a l'augmenter nous establirons toute la correspondance que vous jugerez a propos. (The Correspondence of Henry Oldenburg, IV, 157)

[22] Registres, III, fol. 1.

> La Compagnie estant assemblée M. de Carcavi a dict qu'il a receu ordre de Monseigneur Colbert de faire sçavoir a la Compagnie que Le Roy a nommé Le Sieur Gallois sec. de l'Acad. de Physique et de math. en la place de M. du Hamel.

Duhamel had gone on a voyage with M. de Croissy to Aix la Chapelle and England.

carried out at the order of Cottereau du Clos.[23] Perhaps academicians like Bourdelin, an apothecary, or Gayant, a master surgeon, were appointed because of their technical competence, specially for the tasks they were best able to perform.

On the 22nd of December 1666, the Academy decided on preliminary regulations to govern their meetings. They were to meet twice a week in the king's library. Wednesdays would be devoted to mathematics, Saturdays to physics.[24] In practice, exceptional circumstances suspended this regulation.

> Jeudy 20e Septembre 1668:
>
> Ce jour la Compagnie ayant esté extraordinairement assemblée par un ordre expres du Roy pour examiner un Cameleon qui avoit esté presenté a Sa Majesté par un Pere Capucin qui l'avoit apporté d'Egypte, on a faict plusieurs observations et experiences sur cet animal...25

On the 15th of January 1667, further regulations were laid down.

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[23] B.N. F.Fr., N.A. 5133-49. Procès-verbaux des seances et du laboratoire 1667-99, par Bourdelin, père et fils. N.A. 5147 is entitled 'Mémoire de la despence faitte par Monsieur Bourdelin pour le Laboratoire de l'Academie Royalle des Sciences'. From Guiffrey's Comptes, it appears that members of the Academy were reimbursed by the Treasury for expenses which they had incurred. I have been unable to find a reference to a Treasurer of the Academy.

[24] Registres, I, fol. 1.

> Ce Mercredi 22 de decembre 1666 Il a esté arresté dans la compagnie qu'elle s'assemblera deux fois la semaine le mercredy et le samedy 2 que l'un de ces deux jours, sçavoir le mercredy, on traittera des Mathematiques; le samedy on travaillera a la Physique. 3 comme il y a une grande liaison entre ces sciences on a jugé à propos que la compagnie ne se partage point, et que tous se trouvent a l'assemblée les mesmes-jours.

[25] Registres, IV, fol. 227.

> On a aussy arresté que toutes les choses qui seront proposées dans l'assemblée demeureront secrettes, que l'on ne communiquera rien au dehors que du consantement de la Compagnie; et quand quelcun proposera une chose que ce soit le plus brievement qu'il pourra et que personne ne l'interrompt.26

The 23rd of March 1667, they decided that a member should present his discoveries to the Assembly and they would then have them communicated to the Journal des Sçavants.[27] On Wednesday 21 January 1668, it was resolved that "particular accounts be related in the first hour of each assembly and the rest of the time be employed in working on the principal design".[28]

Each year the Academy decided on general plans of work for particular subjects: mechanics, astronomy, chemistry, anatomy and botany. Members, however, could propose a subject whenever they wished. Plans and proposals having been approved, an individual or group was appointed to implement them and report to the assembly. Sometimes reports extended over a number of weeks, as in the case of Du Clos' examination of mineral waters;[29] at others, the subject required only one meeting. Each week the Company decided which report was to be examined at the next meeting. Work itself was conducted either as a joint venture or, in many cases, left to

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[26] Registres, I, fol. 200.

[27] Registres, II, fol. 159.

> Il a esté arresté dans l'assemblée que si quelqu'un fait quelque nouvelle découverte dans la Physique ou dans les Maths. apres qu'il les aura communiquées a la Compagnie on pourra la faire imprimer ou mettre dans le journal, nommer la personne qui aura fait la découverte et marquer qu'il la communiquée a des personnes qui s'assemblent expres à la recherches des choses naturelles ou exprimer cela d'une autre maniere dont on demeurera d'accord dans l'assemblée.

[28] Registres, I, fol. 250.

[29] Registres, I, fols. 209-10, 246 and B.N.F.Fr. N.A. 5133, pp.18-26.

individuals. Some of the work, like dissections and astronomical observations, was better suited to cooperation, whereas mathematical problems such as 'rules for finding the tangents of curved lines' were best examined by individuals. Both methods were used extensively.

Despite its desire for 'secrecy' the Academy was aware of the need for communication with the outside world. Eager for acclaim and realising their work demanded knowledge of advances made elsewhere, their official policy was to publish their achievements and correspond with other societies and savants. A list of their communications to the Journal des Sçavants is reprinted in Tome X of the Mémoires de l'Académie Royale des Sciences.[30] Many of these found their way to the Philosophical Transactions of the Royal Society.

> March 1669: An observation of Saturne, made at Paris, the 17th of August, 1668 at hor. 11½, et night, by M. Hugens and M. Picart; as 'tis described in the Journal des Scavants of February 11 1669.
>
> April 1672: A relation of the Return of a Great Permanent spot in the Planet Jupiter, observed by Signor Cassini, one of the Royal Parisian Academy of the sciences.

The members spread news of the Academy's affairs by conversation with their friends, in their personal correspondence and by frequenting Parisian literary and scientific circles. Gallois, Auzout, Pecquet, Mariotte and Roberval played an active part in the conferences of the Abbé Bourdelot. In 1668, an official relationship was

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[30] Paris, 1730, Extraits du Journal des Sçavants 1664-72, pp. 451-544.

established with the Académie de Caen and the Royal Society. In January, "Pierre Daniel huet came to the assembly and, in the name of the Academie de Caen, asked for some sort of union or communication between the two...which Carcavi agreed to in the name of the Compagny".[31] In July, Oldenburg embraced Gallois' offer of correspondence and wrote:

> ...I agree with you that it would be to the interest of science that we should undertake a co-operative effort, and employ our pens especially towards rousing the intelligent, uniting their forces, and so working that they may mutually assist one another in making experiments and discoveries in nature and the arts.[32]

A characteristic of the Academy's work in early years was its love of particular, individual discoveries and natural histories, rather than the promotion of a general, all-embracing system. Most of each 'Registre' was devoted to chosen reports on individual experiments, observations and mathematical problems made and examined both in and out of the Assembly. The 9th, 16th and 23rd of February 1667, Auzout, Buot, Roberval and Huygens described their methods "de restituer les lieux des etoilles fixes".[33] On the 10th of March 1667, Pecquet presented a report, "Pour rendre compte a l'assemblée de la dissection que Monsieur Gayen a faite il y a quelque jours de la teste d'un homme...".[34] The 17th of October 1668, "Huygens a parlé de la quadrature arithmetique de

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[31]Registres, I, fol. 248.

[32]<u>The Correspondence of Henry Oldenburg</u>, ed. and trans. A.R. and M.B. Hall, IV, 557.

[33]Registres, II, fols. 156-7.

[34]Registres, I, fol. 80.

l'hyperbole de M^r Mercator qui est inseree dans un journal d'Angleterre".[35] During 1669 the Physics assembly busied themselves with searching for the 'causes of coagulation'.[36]

The annual programmes of work are mainly detailed plans of particular experiments and particular subjects. The indefatigable Du Clos, strongly influenced by the iatrochemists, read his plan for chemistry on 31 December 1666 and recommended that the Academy conduct "la recherche des Principes des Mixtes naturels" by empirically testing the theories he had deduced.[37] The 15th of January 1667, Perrault read his "Proiect pour les Experiences et observations Anatomiques". He said,

> ...tout ce que l'on peut faire en l'anatomie presentement consiste a trouver dans les organes qui sont decouvertes les usages que l'on ignore et a chercher pour les actions qui sont connues des instruments qui soient capables de les faire et que l'on n'a point encor decouverts.[38]

As anatomists did not agree on the function of the various bodily organs, he recommended their observations be directed to finding "les veritables usages". Similarly, their dissections could discover the causes of effects already known, such as lactation and nutrition of the foetus. The method he prescribed was the joint use of reason

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[35]Registres, III, fol. 138.

[36]Registres, VI, fols. 126-141.

[37]Registres, I, fols. 2-16.

[38]Registres, I, fol. 23.

and experiment.

> ...il est pourtant vray de dire que les yeux ne sont pas les seuls guides dans cette recherche et que la Raison fournit aussy de lumieres pour sy conduire qui ne servent pas seulement a s'esclaircir sur l'usage des parties que l'on a trouvées mais mesme sur la necessité ou la probabilité de celles que l'on espere de decouvrir et qu'il peut arriver assez souvent que faute de ce conseil on se travaille inutilement pour des organes et des conduicts que la Raison faict juger n'estre point necessaires.[39]

In 1668(?), Huygens proposed to the physics assembly his plan for a natural history.

> Cette histoire consiste en experiences et en remarques et est l'unique moyen pour parvenir à la connoissance des causes de tout ce qu'on voit dans la nature. Comme pour açavoir ce que c'est que la pesanteur, le chaud, le froid, l'attraction de l'aimant, la lumiere, les couleurs...[40]

The Academy's published work, in the Journal des Sçavants, in pamphlet or book form, also demonstrated the members' love of the particular. Their early treatises, for example, were descriptions of experiments and observations.

> Relation d'une observation faite à la Bibliotheque du Roy, à Paris, le 12 Mai 1667 sur les 9 h. du matin, d'un Halo couronne à l'entour du Soleil, avec un discours sur la Cause de ces Meteores et de celles des Parelies.[41]

> Extrait d'une Lettre à M. de la Chambre, qui contient les observations qui ont été faites sur un grand Poisson disséqué à la Bibliothèque du Roy, le 24 Juin 1667.[42]

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[39] Registres, I, fol. 24.

[40] O.H., XIX, 268.

[41] Paris, 1667. See Journal des Sçavants, 28 Août 1667.

[42] Paris, 1667. See Journal des Sçavants, 28 Nov. 1667.

Observations qui ont été faites sur un lion disséqué à la Bibliothèque du Roy, le 28 Juin 1667, tirées d'une Lettre écrite à M. de la Chambre.[43]

La Nouvelle découverte touchant la Vuë.[44]

Description anatomique d'un Cameleon, d'un Castor, d'un Dromodaire, d'un Ours et d'un Gazelle.[45]

Not till 1671 and 1676 did they publish Mémoires pour servir à l'Histoire naturelle des Animaux and Mémoires pour servir à l'Histoire des Plantes.

Colbert had succeeded in building a living monument to the glory of Louis XIV and the progress of the sciences in France. The Academy enjoyed a freedom which had been denied to Renaudot. But the enquiries of the members were not without restrictions. They benefited from and were restrained by their relationship with the French government, the regulations of their assembly and their relations with other members of a larger scientific community.

Within the Academy there was agreement on what their subject was and what their method and purpose should be. They assembled "expressly for research into natural things".[46] This definition of subject-matter and purpose was most important. Exclusion of other fields of learning - metaphysics, political theory, religion - meant that a particular concept of science could develop unhampered by any connexion with transcendental philosophy. Government support

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[43]Paris, 1667. See Journal des Sçavants, 5 Déc. 1667.

[44]Paris, 1668. See Journal des Sçavants, 17 Sept. 1668.

[45]Paris, 1669. See Journal des Sçavants, 16 Déc. 1669.

[46]Registres, II, fol. 159.

ensured their privacy and spared them the frills of the conferences in polite society. As an institution, their method of research was primarily experimental. As individuals, they might formulate theories and attempt to deduce laws which were true for the past, present and future, without too much interference or censorship by the assembled body. The Assembly, though, frowned on the promotion of 'systems' and refused to take official decisions on matters under debate.

Members were both encouraged and controlled by the opportunities which the Academy provided for co-operation. We notice, for example, that in February and March 1667, Auzout, Buot, Huygens and Roberval proposed several ways to plot the position of fixed stars;[47] in January 1668 the Company examined Huygens' laws of motion;[48] in the late summer and autumn of 1669, Roberval, Frenicle, Buot, Huygens, Duhamel, Marriotte and Perrault took part in a great debate on "La cause de la pesanteur".[49] The closest the Academy came to taking an official decision in this last debate was to have Picard examine Huygens' report, the objections made by Marriotte and Roberval, and Huygens' answer. As members of an institution, however, academicians were forbidden to publish anything without the consent of the whole Company. Of the three examples just mentioned, only Huygens' paper on the laws of motion was published soon after its examination in the assembly.[50] In this way the Academy attempted

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[47] Registres, II, fols. 156-7.

[48] Registres, I, fols. 247-8.

[49] Registres, V, fols. 129-226. See O.H., XIX, 625-45.

[50] Journal des Sçavants, 18 Mars 1669.

to preserve harmony among its members and protect the authors of invention and its own reputation.

This cautious policy meant that objections to their early published work were rare. Nonetheless academicians welcomed criticism and desired that their work be examined by other scholars. Huygens wrote to Oldenburg in May 1669 that he "had hoped that these gentlemen[51] would have examined my method of demonstration in this subject[52] and I should very much like to have either their approval or their disapproval, in case they find something to say either about my hypotheses or about the demonstrations which I have deduced from them".[53]

In turn a substantial proportion of the Academy's early work was devoted to criticism of the books and inventions of others. They examined pumps, schemes for finding longitude at sea, and for de-salting sea-water. Du Clos examined and reported on books and treatises on mineral waters,[54] chalk,[55] gardening,[56] and in the autumn and winter of 1668-9, conducted a laborious experimental examination of Robert Boyle's Tentamina Chimica.[57] In 1668 Roberval

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[51]Messrs. Wren and Wallis.

[52]The laws of motion.

[53]The Correspondence of Henry Oldenburg, ed. and trans. A.R. and M.B. Hall, V, 556-7.

[54]Registres, I, fol. 203.

[55]Registres, I, fols. 308-76.

[56]Registres, VI, fol. 31(?). 9 March 1669 Du Clos reported on a Traité du Jardinage by S^r Pinault.

[57]Registres, IV, fols. 241ff. and VI, fols. 1-30.

examined the De Aquiponderantibus by Archimedes,[58] Mariotte examined the Algebra of J. Rahn translated by Thomas Branker,[59] and Huygens began a prolonged controversy with his report on James Gregory's Vera circuli et hyperbolae quadratura.[60] The co-operation, communication and appraisal of each other's work that existed among members of the scholarly community was a process which regulated, hindered, helped,diffused and heightened the value of its discoveries. Within that community the Académie des Sciences exercised restraint by refusing to authorize publications which did not have the consent of the whole company.

An even more important restraint was the Academy's relationship with its mentors, Louis XIV and Colbert. The Academy was Colbert's offspring, for which he provided. It was natural that he should expect some return for the support and money which he gave. Were the academicians glorified civil-servants wholly dependant "on the humour of a Prince and the favour of a minister"?[61] Did Louis XIV have, as Francis Vernon said, "an effectuall influence upon his royall Academie"?[62]

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[58] Registres, I, fol. 251.

[59] Registres, III, fol. 56.

[60] Registres, I, fols. 258-9. See The Corsespondence of Henry Oldenburg, ed., and trans. A.R. and M.B. Hall, IV-V, for details of this controversy.

[61] O.H., XXII, 657.

[62] The Correspondence of Henry Oldenburg, ed. and Trans. A.R. and M.B. Hall, Francis Vernon to Oldenburg 1 May 1669/11 May(N.S.), V, 507.

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[59] Registres, III, fol. 56.

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[62] The Correspondence of Henry Oldenburg, ed. and Trans. A.R. and M.B. Hall, Francis Vernon to Oldenburg 1 May 1669/11 May(N.S.), V, 507.

Colbert was responsible for the form of the Academy and the choice of members. The Academy was permitted to use the Jardin du Roi[63] and was provided with animals for dissection from Vincennes and Versailles.[64] Each academician received an annual allowance or gratuity; an observatory was built; a laboratory and meeting place whose maintenance costs were paid by the government was stocked with books, manuscripts, instruments and materials; money was available for whatever task the Academy undertook, whether it was an expedition to Cayenne or engravings of different plants.

The problem of what form the Academy should take was one reason for the delay in its foundation. Colbert favoured the establishment of a general academy along the lines of the scheme proposed by Charles Perrault.[65] Perrault had suggested an Academy composed of those who excelled in belles-lettres, history, philosophy and mathematics. The litterateurs, he said, should excel in grammar, eloquence or poetry, the historians in history, chronology or geography, the philosophers in chemistry, simples, anatomy or experimental physics and the mathematicians in geometry, astronomy or algebra. The historians would meet in the King's Library on Mondays and Thursdays, the men of letters on Tuesdays and Fridays and the mathematicians and physicists on Wednesdays and Saturdays.

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[63] see B.N. F.Fr. N.A. 5133 fol. 1 (at the back).

[64] Registres, I, fol. 203.

[65] Perrault's plan is published in P. Clement, Lettres, V, 512. Chapelain, in a letter to Conringius, 12 Sept. 1666, mentioned that Colbert was in favour of a 'general' Academy. (Lettres de Jean Chapelain, ed. T. de Larroque, II, 474).

There would be a general meeting on the first Thursday of each month. But the opposition to the scheme proved to be too strong. The meetings of the historians were feared lest they should debate political and legal affairs; those of the men of letters were attacked for duplicating the function of the Académie Française. Of the original scheme only the mathematicians and physicists remained, for Colbert had neither the desire nor the opportunity to act in a totally arbitrary and authoritarian fashion.

Similarly, in choosing members for the Academy, Colbert, according to Charles Perrault,[66] took the advice of Jean Chapelain, Abbé de Bourséis and Pierre Carcavi. These three along with the Abbé de Cassagnes and Perrault himself formed the "petite Académie" or Académie des Inscriptions et Belles-Lettres. Founded in 1663, the "little academy" was described by Perrault as "une espèce de petit conseil pour toutes les choses dépendantes des belles-lettres".[67]

In the Bibliothèque National there are a few letters,[68] supposedly from Chapelain to Colbert, which support Perrault's claim. Chapelain recommended that the models of existing academies should prove useful in planning the Royal Academy and that extreme care should be exercised when choosing the members of this "illustrious assembly". There were "des Scavans de bonnefoy...des gens dont on ne sçauroit se

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[66] C. Perrault, <u>Mémoires de ma vie</u>, p. 43.

[67] ibid., p. 35.

[68] B.N. Baluze 362, fols. 42-58, especially fols. 55-8. This last letter is printed in P. Clément, <u>Lettres</u>, V, 513-4.

passer dans un dessein aussy grand que celuy de l'Academie Royalle",[69] and others, who made as much noise as possible striving to get themselves known at Court by forming cabals, "dans lesquelles on est de complot de ne dire que du bien de certaines gens, et de parler toujours mal,ou du moins froidement de tous ceux qui n'ont point part a ces Societez ambitieuses".[70] To avoid jeopardising his 'illustrious enterprise' Colbert was urged to seek the advice of disinterested and astute men.

> Il ne faut pas que de petits interests, et de petites vanitez de Sçavant empeschent que tous ceux qui sont propres a cette assemblée n'y soient appellez; et il semble que le mieux qu'on puisse faire pour les connoistre est de s'en raporter a des personnes d'une qualité assez eminente pour estre au dessus de toutes ces foiblesses, et en mesme temps d'un sçavoir assez profond pour pouvoir bien distinguer les differens genies de ceux qui sont propres a faire une experience, ou de ceux qui ont assez de netteté d'Esprit pour les bien receuillir, et enfin de tous ceux qui ont tous les differens talens dont l'assortiment pouroit rendre l'Academie Royale aussi belle qu'utile.71

Colbert and his advisors were able to control the selection of members to the new Academy. Colbert's own most effective influence was financial. To the fledgling Academy he gave generous financial support and encouragement. Table IV (p. 213) gives details of the payments to each member during the period 1664 to 1672.[72]

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[69] B.N. Baluze 362 fol. 56.

[70] loc. cit.

[71] ibid., fol. 57.

[72] Taken from the chapters entitled "Pensions et Gratiffications des gens de lettres" in Guiffrey's Comptes, vol. I.
Figures are in French livres.

TABLE IV

	1664	1665	1666	1667	1668	1669	1670	1671	1672
AUZOUT			1500	1500					
BLONDEL								2000	1500
BOURDELIN			1500	1500	1500	1500	1500	1500	1500
BUOT			1200	1200	1200	1200	1200	1200	1200
CARCAVI	1500	1500	1500	2000	2000	2000	2000	2000	2000
CASSINI					3000	6750		9000	10500
COUPLET					600	600	600	800	800
DU CLOS			2000	2000	2000	2000		2000	2000
DUHAMEL				1500					
FRENICLE			1200	1200	1200	1200	1200	1200	1200
GALLOIS					1500	3000	1500	1500	1500
GAYANT			1200	1200	1200	1200	1200	1200	1200
HUYGENS	1200	1500		6000	6000	6000	6000	6000	6000
C. DE LA CHAMBRE	2000	2000		2000	2000	2000			
LA VOYE MIGNOT				800		900			
MARCHANT			1200	1200	1200	1200	1500	1500	1500
MARIOTTE					1500	1500	1500	1500	1500
NIQUET			800	800	1000	1600	1000	1000	1000
PECQUET				1200	2400	1200	1200	1200	1200
PERRAULT			1500	1500	2000	2000	2000	2000	2000
PICARD			1200	1200	1200	1500	1500	1500	1500
PIVERT				600		600	800	800	
RICHER			800	1000	1000	1000	1000	2000	2500
ROBERVAL			1500	1500	1500	1500	1500	1500	1500
ROEMER									1000

Work on an observatory commenced after Auzout, Frenicle, Picard, Buot and Richer marked out a meridian on the site chosen near the Faubourg St. Jacques on 21 June 1667.[73] C. Wolf[74] has calculated that the cost of its construction for the seventeen years 1667-83 totalled 713,954 livres 15 sols and 11 derniers. For the years 1667 to 1672, when most of the work was done, costs came to 613,060 l. 8 s. 9d. Over the same six year period the "Bibliothèque du Roi et Académie des Sciences" received 152,062 l. 6s. 10d. The payment each year was as follows:

TABLE V [75]

	Livres	sols	derniers
1667	8,165	15	4
1668	18,280	14	10
1669	18,576	16	0
1670	51,916	14	0
1671	29,087	8	8
1672	26,034	18	0
Total	152,062	6	10

[73] Registres, II, fol. 73.

[74] C. Wolf, Histoire de l'Observatoire de Paris de sa fondement à 1793, Paris, 1902, p. 15.

[75] Guiffrey, Comptes, Récapitulation des dépenses. Académie des Sciences et Bibliothèque du Roi, I, 1387.

Unfortunately, payments to the king's library and the Académie des Sciences were included in the same account. Many items only incidentally relate to the Academy. In 1670, for example, three items which help account for the large amount spent in that year are:

> 8 mars: au S[r] Mentel, docteur en médecine, pour le payement des livres de sa bibliotèque, achetez pour mettre en celle de S.M.
> £16,000
>
> 22 juillet: au S[r] Pelissary, pour son reimboursement de pareille somme qu'il a advancée a compte de 333 douzaines de peaux de maroquin de Levant qu'il a fait venir pour la bibliotèque du Roy.
> £12,000
>
> 20 avril 1670: au S[r] Carcavy, à compte des dépences qu'il a faites à la bibliotecque du Roy.
> £7,000 [76]

Where, however, must the line between 'library' and 'academy' be drawn? How important was comfort and pleasant surroundings to the work of the Academy? Carcavi, as President, had the inclination to buy scientific books and manuscripts. As Garde de la Bibliothèque du Roi, he had the opportunity.

Other items refer directly to the Academy. They are payments for instruments, models of machines, corpses for dissection, sundry expenses incurred by members of the Academy.

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[76] ibid., I, cols. 447-8.

Annee 1667

31 Janvier 1669: à Isaac Thuret, horloger, a compte des ouvrages qu'il a fait à l'Académie des Sciences. £500

18 fevrier 1669: à Pierre Le Moine, pour son reimboursement de pareille somme qu'il a avancée pour l'achapt de plusieurs instrumens de mathématiques, qu'autres despences par luy faites a l'Académie des Sciences.

£1578 · 2 · 0 [77]

Annee 1668

Au Sieur Couplet idem, tant pour plusieurs animaux pour les dissections, que pour plusieurs machines et instrumens pour les expériences de phisique.

£1022 · 7 · 0

24 Juillet 1669: au S[r] Bourdelin, pour son reimboursement de plusieurs menues despences par luy faites dans le laboratoire de lad. Académie.

£244 · 17 · 0 [78]

Annee 1670

12 may 1670 - 4 janvier 1671: à Gosselin, armurier, pour plusieurs modelles de machines et instrumens qu'il a faits pour l'Académie.

£1889 · 10 · 0 [79]

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[77] ibid., I, col. 230.

[78] ibid., I, cols. 270-1.

[79] ibid., I, col. 447.

The record of payments to the Academy is not confined to the three accounts entitled "Pensions et Gratiffications aux gens de lettres", "L'Observatoire" and "Bibliothèque du Roi et Académie des Sciences". Guiffrey's <u>Comptes</u> are a mine of information needing extensive exploration before anything approaching a thorough knowledge of the government's expenditure on the Academy can be achieved. There is, for example, under "Diverses Despences", "Graveurs de Planches" and "Officiers qui ont gages pour servir générallement dans touttes les maisons et Bastimens de sa Majesté":

<u>Annee 1670</u>

30 janvier: Aux Srs Richer et Meurice, mathématiciens, envoyées à la Cayenne pour y faire des observations astronomiques utiles à la navigation, pour leurs appointemens de la présente année, savoir: aud. Richer £2,500 et aud. Meurice £1,200
£3,700 [80]

<u>Annee 1671</u>

31 juillet 1671: au Sr Robert, graveur, pour douze planches qu'il a gravées de plantes differentes pour le recueil de plantes que fait l'Académie des Sciences
£1,164 [81]

<u>Annee 1670</u>

Gossellin - retenu pour travailler aux instrumens de mathématiques pour l'Académie
£200 [82]

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[80] ibid., I, col. 476.

[81] ibid., I, col. 544.

[82] ibid., I, col. 463.

It is sufficient for our purposes, however, to show that the French government offered extensive and unrivalled financial support for the advancement of the arts and sciences.

Such a price paid by the government entitled it to expect results from the new Academy. Colbert, for instance, desired that it 'should become the most learned and most famous of all Europe', should reflect the glory and munificence of Louis XIV and should produce something useful for society.[83] The public, too, had great expectations. Henri Justel's letters to Oldenburg continually refer to his hopes for a worthy achievement. "It is essential that it [the Academy] do something, and produce something worthy of its promise...";[84] "the King refuses nothing to the Academy. If it does nothing it will not be for want of assistance.";[85] "the Academy will do something in time...and if it does not it will not be the fault of Mr Colbert, who takes great pains and who gives everything anyone could wish."[86]

Faced with such demands, the Academy attempted to prove its utility. The members searched for applications of their knowledge and showed an interest in the advancement of the arts by examining machines and inventions. Perrault justified the physicists'

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[83] see J.B. Duhamel, Regiae, Caput Primum, Quae rationes moverint Regem Christianissimum ut Scientiarum Academiam institueret, p. 2, and C. Perrault, Mémoires de ma vie, pp. 219-20.

[84] The Correspondence of Henry Oldenburg, ed. and trans. A.R. and M.B. Hall, IV, 330-2.

[85] ibid., IV, 502-3.

[86] ibid., IV, 477-9.

contemplation and dissection of the human body as "le sujet de l'Employ des Medicaments tant simples que Composez dont la Botanique et la Chymie fournissent la connoissance".[87] Pecquet hoped to explore the possibilities of what he called transfusory medicine.[88] The astronomers emphasised the utility of their observations for history, geography and navigation.

> L'observation des Eclypses est si utile, et l'utilité en est si connue qu'il ne faut pas s'estonner, si tous les astronomes prennent tant de soin, quand il en arrive pour les observer avec toute l'exactitude qui leur est possible, puisqu'elles peuvent servir plus que toutes les autres observations pour rectifier les mouvemens du soleil et de la Lune, et pour scavoir sur la terre la difference des meridiens, ou la longitude, sans laquelle la Geographie, et la Navigation sont incertaines: Et si l'on n'avoit autrefois observé les Eclypses, nous manquerons du moyen le plus sur que nous ayons pour rectifier la Chronologie de l'histoire.[89]

On the 23rd of May 1668 the Academy was told that Colbert wanted more exact maps of France.

> ...Mr de Carcavi ayant dict a la Compagnie que M. Colbert desiroit que l'on travaillast a faire des Cartes Geographiques de la france plus exactes que celles qui ont esté faictes iusqu'icy, et que la Compagnie prescrivist la maniere dont se serviroient ceux qui seront employez a ce dessein.[90]

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[87] Registres, Proiect pour les Experiences et Observations Anatomiques, Jan, 1667, I, fol. 22.

[88] Registres, Mémoire, Nov. 1669, VI, fol. 181vo.

[89] Registres, Observation de l'Eclypse du Soleil du 2^{e} Juillet 1666 faite dans la maison de M^{r} Colbert, II, fol. 20.

[90] Registres, III, fol. 25.

The matter was deferred till the following Wednesday. In the meantime, they would seek the advice "des plus habiles Geographes". Niquet was appointed to ask M. Samson, Geographe ordinaire du Roy, to come to next Wednesday's meeting.[91] On the 30th of May it was decided that they should experiment with different methods for making a map of the environs of Paris "et d'envoyer pour cela un homme expres sur les lieux qui executera les ordres de Mess. de Roberval et Picart que la Compagnie a nommez a cet effet".[92] On August 1st M^r du Vivier presented the beginning of his map of the 'Isle de la France'.[93]

The members' plans reflected an utilitarian bias. In a Discours written 1667-8 Huygens recommended:

> Pour les inventions qui consistent en pratique comme des machines utiles a quelque chose elles sont plus accommodees pour estre l'entretien de l'assemblee que les precedentes de la pure Theorie, et parce que l'intelligence de celles que l'on voit donne souvent occasion et moyen d'en inventer d'autres comme aussi a perfectionner ces premieres, il seroit bon de faire construire des modelles de toutes les machines utiles qui sont en usage comme de differents moulins, de pompes, et autres inventions pour l'elevation des eaux, de celles qui servent a mouvoir des grandes pesanteurs et autres qu'on emploie dans divers mestiers, les quels modelles l'on arrangeroit dans une chambre, avec l'eclaircissement necessaire par escrit adjoute a celles qui en ont besoin. L'on emploieroit utilement le temps a examiner ces machines les unes apres les autres... L'on fera l'essay de l'Invention des longitudes sur mer par les Horloges a pendule, que l'on y a desia veu servir utilement. Et pour cela on mettra de ces horloges dans des vaisseaux qui vont en Amerique ou a d'autres voiages de long cours.

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[91] loc. cit.

[92] ibid., III, fol. 30.

[93] ibid., III, fol. 56.

> L'on essaiera ce qui se pourra faire pour les longitudes sur terre qui doivent servir a redresser les Cartes Geographiques et veoir si entre autres moyens celuy du Meteore qu'on nomme Trajection d'Estoille y peut servir de la facon que je me le suis imaginé.[94]

On the 30th of March 1667 Auzout proposed that the Academy entertain a dialogue with artisans.

> M. Auzout a proposé que quelques uns de la Compagnie eussent commission de voir tous les ouvriers, voir leurs instrumens, scavoir ce qui leur manque, apprendre leurs secrets, leurs sophisteries etc. M. de Carcavi a tesmoigné que la chose se pourroit faire aisement par le moyen des ouvriers qui travaillent pour le Roy.[95]

Couplet was elected to undertake this task.

Three inventions, which date from the Academy's infancy, recorded in Gallon's Machines et Inventions Approuvées Par l'Académie Royale des Sciences 1666-1701, were the "Equerre Azimutale par M. Buhot", the "Machine pour mesurer la force mouvante de l'air par M. Huyghens" and the "Machine Hydraulique inventée par M. de Francini". The latter, examined by the Academy in 1668, was later used in the construction of a fountain in the garden of the king's old library.[96]

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[94] O.H., XIX, 265-7. In a plan for mechanics, written about the same time, Huygens wrote that they should consider, "Les machines diverses dans tous les arts mechaniques comme de Charpentiers, Tourneurs, Tisserans, Tireurs d'or et de fer. Marechaux, Batteurs de fer blanc, Tailleurs de pierres, Polisseurs de glaces, Fondeurs de Canon" (O.H., XIX, 25).

[95] Registres, II, fol. 161.

[96] Gallon, Machines et Inventions Approuvées Par l'Académie Royale des Sciences, 7 vols., Paris, 1735-77 (1754), I, 148.

The Procès-Verbaux mention some of the schemes which the Academy rejected. At Colbert's request, the Company examined Sr Douceur's water-pump (11th April 1668),[97] the methods of Reusner (May/June 1668),[98] Graindorge (20th February 1669)[99] and Des Hayes (October 1669)[100] for determining longitude at sea, and the plan of Mr Othon of the Académie de Caen (7th December 1669) for de-salting sea-water.[101] Each of these was rejected. Other proposals examined by the Academy, to which the Registres make only a brief reference, include a plan for smokeless chimneys,[102] a double-barrelled rifle which fired six shots,[103] a machine for quarrying stone[104] and "inventions to raise water higher than its source".[105]

In the light of the Academy's close relationship with royal authority it is tempting to see its members as Colbert's salaried assistants. Colbert maintained a lively interest in the Academy's

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[97] Registres, III, fol. 1.

[98] Registres, III, fols. 25-53. See O.H., XXII, 218-26.

[99] Registres, III, fol. 262. See O.H., XXII, 229-32.

[100] Registres, V, fol. 184. See O.H., XXII, 232-3.

[101] Registres, VI, fol. 187.

[102] Registres, I, fol. 246.

[103] Registres, I, fol. 258.

[104] Registres, I, fol. 256.

[105] Registres, I, fol. 258.

work, corresponded with members and asked them to perform certain tasks, and he seems occasionally to have inspected the work they were doing and the plans they had. We have noticed that he asked for more exact maps of France, encouraged co-operation with the Académie de Caen and appointed academicians to examine certain inventions, particularly those for determining longitude at sea. We know that the mathematicians first met in Colbert's house, that Colbert visited the assembly in the autumn of 1667[106] and seems to have asked individual members to draw up plans of work for his perusal.[107] In 1670 and 1672 when Richer went to the East Indies and the West Indies, he wrote to the Intendant at Rochefort and the directors of the West Indies Company arranging Richer's passage and accommodation, and asked that Richer be accorded "...toutes les assistances dont il pourra avoir besoin".[108] In 1671 and 1672 he made similar arrangements for Picard's expedition to Denmark and politely asked Picard for an account of how his work was progressing.[109] Colbert's interference, however, did not amount to rigid control or insufficient, niggardly aid. It was not a nagging pressure on the Academy. Instead, Colbert proved to be an encouraging benefactor whose interest benefited the development of the arts and sciences.

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[106] The Correspondence of Henry Oldenburg, ed. and trans. A.R. and M.B. Hall, III, 578/80.

[107] see P. Clément, Lettres, Note de Huygens avec des observations de Colbert, V, 523-4.

[108] P. Clément, Lettres, V, 294 and note 1.

[109] ibid., V, 314, 318, 319-20, and notes.

It would seem safe to infer that it was in order to assure itself of Colbert's continued support that the Academy emphasized the value of its work for the glory and economic health of the French king and scoiety. But it must be remembered that utilitarian arguments were used long before the foundation of the Academy. Renaudot, for example, stated that his sole preoccupation was with "public utility" and with "inventions that would profit the public".[110] Descartes, in his preface to the French edition of his Principes, claimed that his philosophy was useful for both the state and the individual. Philosophy was the study of 'sagesse' and by 'sagesse' "...on n'entend pas seulement la prudence dans les affaires, mais une parfaite connoissance de toutes les choses que l'homme peut sçavoir, tant pour la conservation de sa santé et l'invention de tous les arts".[111] Samuel Sorbière, in a discourse read to Montmor's academy on 14 June 1658, urged "...nous devons mesler dans nos Entretiens l'Histoire et les Relations de tout ce que nous sçavons d'utile et de curieux dans les Arts et les Sciences qui s'appliquent immédiatement aux commoditez de la vie".[112] Furthermore, it is only fair to point out that the academicians' idea of utility was flexible. Perrault, in his "Project de la Botanique" (1667), wrote that the study of the medicinal possibilities of herbs and plants must not be judged unworthy subject-matter for the

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[110] Premiere Centurie des Questions, Avis au Lecteur, not pag.

[111] O.D., IX-2, nouv. pres., preface, p. 2.

[112] Lettres et Discours de M. de Sorbière, p. 200.

natural philosopher, "a qui toutes sortes de veritez doivent estre pretieuses, quand elles n'auroient point d'autre utilité, que celle de le tirer de quelque Erreur que ce soit".[113] Pecquet, in his plan for physics (1669), claimed that the dissections and chemical analyses made in the Academy would prove useful for preserving health, prolonging life and advancing the study of anatomy.[114] Huygens' interest in machines and inventions was inseparable from his interest in mechanics and astronomy.

When there was every possibility of the foundation of a royal academy, however, it is noticeable that propagandists from Parisian assemblies laid more and more stress on the utility of their work. Sorbière, in a letter to Colbert of 25 April 1663, described his address of the same month as something "qui pourroit aboutir à quelque chose d'importance pour le public, si elle estoit consideree par ceux qui travaillent a l'ornemẽt de la France".[115] Francois Hotman's report to Colbert on the work of Thevenot's group emphasized the Company's utilitarian aims: "Le dessein que c'est proposé cette compagnie est l'avancement des artz and des autres connoissances dont les hommes peuvent tirer quelque usage...".[116] Already one member had translated into French many of the secrets of foreign artisans which should help solve the problems facing navigation,

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[113] Registres, I, fols. 37-8.

[114] Registres, VI, fols. 181-2.

[115] B.N. Cinq Cents de Colbert 485 fol. 445.

[116] B.N. Clairambaut 566 fol. 264.

mining and agriculture. The Company hoped to publish these, do research on others and begin a dialogue with "all sorts of artisans"[117] so that their knowledge of mechanics, chemistry and natural history might prove useful in perfecting the arts. The enthusiasm of these propagandists for utilitarian arguments was heightened by the realisation that they were among the strongest arguments they could use in appealing for royal patronage. Similarly, academicians stressed the functional purpose of their work in an attempt to ensure that the sun-king would continue to bestow his favours upon them. The phrase, "...quand elles n'auroient point d'autre utilité", in the quotation from Perrault's plan for botany, illustrates the concern that most members felt. Bourdelin, for example, began his 'Projet de travail pour l'annee 1668' with the statement "L'Assemblee n'ayant pour But que la gloire et la grandeur de sa majeste...".

The foundation of the Academy marked an important stage in the institutional growth of the natural sciences in France. Unlike the English Royal Society, the French Academy was financially dependant on its royal patron. Luckily, Colbert's enthusiasm and encouragement fostered a workable compromise and process of beneficial exchange between the government's and the Academy's interests, and admittedly, the pressure which he exerted on the Academy was not the crampening pressure of his successor Louvois. But it was a pressure nonetheless. Academicians recognised that they were servants of the state, that they should meet Colbert's demands and attempt to satisfy his interest in inventions such as those which claimed a solution to the problem of determining longitude at sea.

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[117] loc. cit.

CHAPTER X

JACQUES ROHAULT, CARTESIANS AND CENSORSHIP

The work of Jacques Rohault, like that of Théophraste Renaudot and the infant Académie des Sciences, was disturbed by the threat of persecution. It was affected by objections made both inside and outside the scientific community. Influenced by events in the scientific world, Rohault endeavoured to defend Descartes' doctrine of a plenum by using the Torricellian experiments on vacua to his own advantage. Persecution of cartesianism by 'church and state' modified his attitude to Aristotle. The same persecution may have encouraged his particularist approach to physics: certainly it involved him in a time-consuming campaign to get his work accepted by the Theological Faculty of the University of Paris.

Descartes' work had not failed to provoke quarrels in the learned world. In the seventeenth century disputes appeared in all quarters of Europe. In France and in Descartes' lifetime, among the most famous debates were those with Fermat and Roberval,[1] who were critics of certain scientific ideas, and those with the objectors to his _Méditations_.[2] Later in the century battles raged between

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[1] Descartes' disputes with Fermat and Roberval began after the publication of _La Dioptrique_ and _La Geométrie_ in 1637. See _Lettres de M. Descartes_, III, Paris, 1667.

[2] _O.D._, IX, 73-244.

Régis and Huet[3] and between Foucher and Malebranche[4] over the value and interpretation of Descartes' philosophy. Such disputes, however, must not be confused with censorship or persecution, even though there were works born of that persecution, such as Louis de la Ville's _Sentiments de M. Descartes touchant l'essence et les propriétés des corps opposées à la doctrine de l'Eglise et conformes aux erreurs de Calvin sur le sujet de l'Eucharistie._[5] Censorship involves official supervision of morals and conduct. It involves an official body either set up for that purpose or with that as part of its functions. Control is usually exercised by licensing all publications and by suppressing what is thought to be immoral, seditious or inopportune, or in seventeenth century language, whatever was thought "à troubler la tranquillité de l'Etat et à corrompre les moeurs des sujets du roi".[6]

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[3] P.D. Huetii, _Censura philosophiae cartesianae_, Paris, 1689. P.S. Regis, _Réponse au livre qui a pour titre P.D. Huetii Censura..._, Paris, 1691. Huet replied in the preface to the fourth edition of his work, Paris, 1694.

[4] N. Malebranche, _De la Recherche de la Verité..._, Paris, 1674.
S. Foucher, _Critique de la Recherche de la Verité..._, Paris, 1675.
N. Malebranche, _Preface pour servir de Réponse à la critique du premier Volume_
S. Foucher, _Réponse pour la Critique à la Preface du second volume de la Recherche de la Verité..._, Paris, 1676.
On this dispute, see R.A. Watson, _The Downfall of Cartesianism, 1673-1712_, The Hague, 1966.

[5] Paris, 1680.

[6] M. Marion, _Les Institutions de la France aux XVII^{e} et XVIII^{e} siècles_, Paris, 1923, p. 77.

During the personal reign of Louis XIV, the judicial power to condemn publications rested with the king, who could issue an edict, decree or ordinance at will, the Parlements, whose powers at minimum were those of sovereign courts established to render justice in the king's name, and in Paris, the courts of the Châtelet. Moreover, numerous laws were passed in the sixteenth and seventeenth centuries concerned with regulating printing and publishing.[7] A special body of control, for example, was established and the number of printers in each town was limited. At first, each book dealing with religion needed examination and authorisation by the Paris Theological Faculty. By 1666, control of all books by registration and 'Privilege' was in the hands of the Chancelier d'Etat and four paid officials who were not necessarily chosen by

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[7]The ineffectiveness of some of this legislation is emphasised by an 'Extraict des Registres du Conseil d'Etat', 6 October, 1667. It reads:

> Le Roy ayant esté informé de l'inexecution des Edicts, Statuts, Reglemens et Arrests sur le fait de l'Imprimerie et Libraire et de plusieurs abus causez par le nombre excessif des Maitres Imprimeurs, Libraires et Relieurs, qui sans avoir la capacité requise et necessaire, ont esté receus ou se sont établis depuis quelques années en plusieurs villes du Royaume, dans lesquelles ils impriment, vendent et debitent toutes sortes de Livres sans aucune Approbation ny Permission, et dont les impressions se trouvent aussi tres-souvent defectueuses; A quoy estant necessaire de pourvoir, et d'arrester le cours des desordres d'une si dangeureuse consequence. SA MAJESTE EN SON CONSEIL, a ordonné et ordonne, Que les Ordonnances cy-devant faites, les Arrests, Statuts et Reglemens concernans l'Imprimerie et Librairie, seront executez selon leur forme et teneur; Et ce faisant defenses à tous Imprimeurs, Libraires et Relieurs, d'imprimer, vendre et debiter aucuns Livres sans Privilege scellé du grand sceau ny aucuns Livrets ou Feuilles volantes sans la Permission expresse du principal Magistrat des lieux à peine de punition corporelle.

B.N. F.Fr. 21832 fol. 142.

the Theological Faculty.[8] In addition, corporate bodies, such as universities, religious orders and the Church, had their own machinery for suppressing what they considered prejudicial to the religion, morals and peace of their members. Outside France, and of some importance for a Catholic king and country, was the Index of books banned by the Congregation of Cardinals in Rome.

Descartes himself maintained at least a tactical deference for the authority of the Holy See, the Jesuits and the Doctors of the Paris Theological Faculty. In 1633, after the condemnation of Galileo, he postponed publication of his treatise Le Monde. In a letter to Mersenne, dated February 1634, he wrote, "...j'ai voulu entièrement supprimer le Traité que j'en avais fait et perdre presque tout mon travail de quatre ans, pour rendre une entière obéissance à l'Eglise, en ce qu'elle a défendu l'opinion du mouvement de la terre".[9] In the final article of his Principes, he submitted all his opinions "au jugement des plus sages et à l'authorité de l'Eglise".[10] In the dedication of his Méditations to the "Deans and Doctors of the Holy Paris Faculty of Theology", he wooed, flattered and appealed to them to correct any errors and add what was necessary to his rational proof of the existence of God

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[8] For the above information, see Marion, op cit., pp. 76-78; pp. 422--33; pp. 489-93.

[9] O.D., I, 281.

[10] O.D., IX, 325.

and the difference of body and soul, so that they might give approbation and public testimony to their truth and certainty.[11]

Such manoeuvres were of no avail. A growing opposition saw cartesian methodic doubt giving free rein to a dangerous scepticism. More important for the Church, Descartes' definition of matter was seen to conflict with the Aristotelian basis of Thomist philosophy and to undermine the orthodox explanation of the mystery of the Eucharist. In the second half of the seventeenth century the official organs of censorship, with the notable exception of the Parlement of Paris, took steps to combat cartesianism. Rohault's own difficulties became enmeshed with those of cartesianism generally.

In November 1663, Descartes' works of philosophy were put on the Index, albeit ambiguously and with the qualification "donec corrigantur". A transcript from the decree reads:

> Quo decretur damnatur et prohibentur cum aliis aliquot libris, Renati des Cartes opera sequentia donec corrigantur. De prima philosophia in qua Dei existentia, et animae humanae a corpore distinctio demonstratur. Cui adjunctae sunt variae objectiones doctorum virorum cum responsionibus auctoris - Amstelodami, 1650. Notae in programma quoddam, sub finem anni 1654 in Belgio editum cum hoc titulo; explicatio mentis humanae sive de anima rationali, ubi explicatur quid sit et quid esse possit.
>
> Epistola ad Patrem Dinet soc. J. per Franciam praepositum provincialem
>
> Epistola ad celeberrimum virum D. Gisbertum Voetium in qua examinatur duo libri nuper pro Voëtio Ultrajecti Simul editi, primus de confraternitate mariana, alter de Philosophia cartesiana.

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[11] O.D., IX, 4-8.

> Passiones animae, libellus gallice ab eodem
> auctore conscriptus, nunc autem in exterorum
> gratiam latina civitate donatus ab H.D.M.J.U.L.
> Amstelodami, 1650.
> Ejus dem auctoris
> opera philosophica.[12]

The ambiguity of the clause "donec corrigantur" and the mention of specific editions lessened the impact of the decree. At least, it did not impede publication of future editions of Descartes' works or of works not already published.

In France, condemnation came mainly from the University of Paris and the government. On June 25th, 1667, during the funeral service celebrating the reburial of Descartes at Ste. Geneviève, a verbal order came from the Court forbidding pronouncement of an oration by Pierre Lallemant.[13] Lallemant, in his "Journal", stated that, prior to this date, the university authorities had let him know that they did not think that their Chancellor should give approval to cartesian doctrine in such a fashion.[14]

In 1671, the Archbishop of Paris, François de Harlay, called together the Rector, deans of the "superior faculties", "procureurs des nations" and the majority of the "principaux" of the colleges in the University of Paris and informed them that the king wished

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[12] cited by Abbé G. Monchamp, Histoire du Cartésianisme en Belgique, Bruxelles, 1886, p. 389 note.

[13] A. Baillet, Vie de Descartes, II, 440. Lallemant was "prestre Chanoine Régulier de l'ordre de St. Augustin de la Congregation de France, prieur de l'abbaye de Ste. Geneviève et chancelier de lad. abbaye de l'université de Paris" (Bib. Ste. Geneviève, Mss.277 p.177).

[14] Bib. Ste. Geneviève, Mss. 1891, Autobiographie ou Journal autographe du P. Lallemant 1622-72, fol. 77^{ro}.

them to spurn the new cartesian opinions and to teach nothing "other than that stipulated in their rules and statutes"; which they promised to do.[15] Le Grand Arnauld, in his Mémoire sur les sollicitations que fait M. Morel..., claimed that Morel, Dean of the Theological Faculty and a zealous adversary of Jansenism, "...fait toutes sortes de poursuites pour obtenir quelque chose, soit à la Faculté de Théologie, soit à l'Université, soit au Parlement, pour faire condamner toute autre philosophie que celle d'Aristote".[16]

The attempt to gain the support of the Parlement of Paris failed, a failure which is partially explained by the favourable reception of a clandestinely published Arrest Intervenu[17] by Nicolas Boileau, Jean Racine and François Bernier and the manuscript Mémoire sur les sollicitations... by Antoine Arnauld. Each in its own way actively discouraged condemnation. The Arrest satirised

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[15] C. Du Plessis D'Argentré, Collectio Judiciorum de novis erroribus, III, 138.

[16] V. Cousin, Fragments Philosophiques, 3e éd., Paris, 1838, p. 182. Cousin entitles the piece 'Plusieurs raisons pour empescher la Condemnation de la philosophie de Descartes', and as such it appears in B.N. F.Fr. 17155. In B.N. F.Fr. 14837 and 14699 it is entitled 'Mémoire sur les sollicitations que fait M. Morel... pour obtenir du Parlement un arrest qui condamne toute autre philosophie que celle d'Aristote'.

[17] Arrest Intervenu. Requeste des Maitres es Arts, Professeurs, et Regens de l'Université de Paris presentée à la Cour Souveraine de Parnasse: Ensemble l'Arrest intervenu sur ladite Requeste. Contre tous ceux qui pretendent faire, enseigner, ou croire de Nouvelles Découvertes ne soient pas dans Aristote. A Delphe par la société des Imprimeurs Ordinaires de la Cour de Parnasse, 1671.

the presumption of Parlement and the University to dictate to 'Nature': "La Cour souveraine de Parnasse...fait aussy tres expresses deffenses et inhibition au sang d'estre vagabond, d'errer ny circuler dans le corps, sur peine abbandonnée jusques à la derniere goutte à la Faculté de Medécine",[18] arguing that if Descartes was condemned for having written something not in Aristotle, then all the discoveries of the century should be condemned, which was ridiculous. The Mémoire, written in a more serious style, pointed out that history and reason show how futile it is for civil authority to condemn the opinions of natural philosophers. If Parlement condemned Descartes now, said the author, it would only serve to stir up dissension and disturb the Peace of the Church.

Other universities, however, soon followed the example of Paris. The disputes which raged at the University of Angers between 1674 and 1678 involved most of the possible organs of censorship and more issues than the refusal to allow Descartes to be taught. The University authorities, arguing that Ancient doctrine and truth were being replaced by a new and erroneous cartesian heresy, injurious to Faith, the Sovereign and the State, sent a 'placet' to the king complaining of the pernicious doctrines being taught. Orders were sent to the Rector to stifle those doctrines. At a convocation of the University, 11 February 1675, the king's letter and that of his minister were registered and it was ordered that they

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[18] ibid., p. 12.

should be posted in the "lieux ordinaires". All the principals, superiors and philosophy professors of the colleges and religious houses were to come to the Law School to hear the king's orders. Furthermore, it was declared, all the philosophy regents should have their written work examined by the University and no thesis should be printed without their consent.

The refusal to submit to this deliberation by Père Coquery, Superior General of the Oratorian college, effectively supported for a short time by the Parlement of Paris, meant that outside the doctrinal content of the philosophy courses of Bernard Lamy[19] and

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[19] Bernard Lamy (1640-1715), Oratorian philosophy teacher at the College d'Anjou 1673-75. The Angers University authorities examined his 'cahiers de Physique' of 1675 and declared:

> Dans lesquels 4 Cahiers nous avons remarqué que ledit L'Amy suit en toutes occasions la doctrine et les sentiments de des Carthes defendus d'estre enseignez par sa Majesté; que conformément aux deux principes fondamentaux de cet Auteur il ne définit point autrement l'Ame que Substantia cogitans, et le Corps que Substantia extensa.

An even more severe indictment was made of his 'cahiers de Morale':

> Pour ce qui concerne 4 Cahiers de Morale aussi presentez par ledit L'Amy,... Nous declarons y avoir trouvé plusieurs Propositions temeraires, expliquées en termes odieux, et injurieux aux Monarques, aux Princes, aux Gouverneurs et aux Magistrats, lesquels dans l'état de la nature corrompüe et sujette au peché, comme elle est aujourd'huy, il accuse de n'agir que par injustice et ambition, et faire tout pour l'amour d'eux-mêmes, opprimer les peuples et les immoler a leurs passions de gloire, d'avarice et de volupté; de n'estre empechez d'usurper toute chose que par l'impuissance ou la crainte de n'y pas rèuissir; toutes lesquelles maximes semblent plus propres à exciter dans le coeur des sujets des sentiments de revoltes, et d'aversion pour la Personne Sacrée des Roys, pour les Gouverneurs et Magistrats, qu'à inspirer la veneration et le respect qui leur sont dus.

(Sumptum ex Registro Universitatis Andegavensis, from Relation fidèle.., pp. 47-51. Cited in F. Girbal, Bernard Lamy, Paris, 1964, pp.164-5).

Cyprien de Villecroze,[20] not only University but Royal authority was called into question. The decree by the Parlement of Paris annulling the University deliberation was soon quashed by an answering 'Arrest du Conseil d'Etat'. The immediate outcome was that Lamy's philosophy course was examined by the University and the Paris Faculty of Theology, who declared that,

> P. L'Amy est tout rempli des sentiments de Baius, qui ont été condamnez par les Papes Pie V et Gregoire XIII et Urban VIII et par la Faculté de Théologie de Paris; que de ces faux principes il en tire des consequences heretiques, seditieuses, iniurieuses et préiudiciables à toutes les personnes constituées en dignité, et qui choquent directement le pouvoir des Souverains, specialement de ceux dont tous les Etats sont successifs.21

Lamy was exiled from Angers and forbidden to preach or teach anywhere in the kingdom. The affair did not end there, for during the next few years, more Oratorians, notably Cyprien de Villecroze and Vincent Pelaut, had their work censored for containing opinions of Descartes, Baius and Jansen. Only when Daniel le Roy, a former 'approved' professor, was recalled, was the University satisfied.[22]

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[20] Villecroze was also a philosophy teacher at the Collège d'Anjou.

[21] Cited in F. Girbal, Bernard Lamy, p. 174.

[22] The information concerning the University of Angers comes from 'Extraits de C.-G. Pocquet de Livonnière,'Université d'Angers', Bib. Municipale d'Angers Mss. 1253 et du Journal ou relation fidèle de tout ce qui s'est passé dans l'Université d'Angers au sujet de la philosophie de Descartes, s.l. 1679', in Girbal, op. cit., pp. 136-77; C. Du Plessis D'Argentré, Collectio Judiciorum, III, 338-9, and A.N. M 230.

In 1677 the Theological Faculty of the University of Caen declared "principia Philosophiae Renati Descartes saniori Theologorium Doctrinae contraria nobis videri" and threatened to deprive of their degrees and privileges anyone who cultivated Descartes' opinions.[23] According to Bayle,[24] Pierre Cally, professor and cartesian interpreter of the Eucharist, was sent into exile along with two other priests of the town.

Influenced by the troubles at Angers and Caen, three of the more suspect teaching orders felt it necessary to reconfirm earlier statutes forbidding the teaching of any doctrine other than that of St. Thomas and emphasising their aversion for novelties. In 1675, the Chapter General of the Benedictines of St. Maur threatened with expulsion those of the order who taught that the essence of a body was its extension, denying accidents real distinction from matter.[25] In 1678, the Chapter General of the Genofevins forbade "tous les Professeurs de Théologie d'enseigner aucune Doctrine contraire à celle de l'Eglise, ou qui pourroit être suspecte des sentiments de Jansenius et de Baius condamnés et desapprouvés par le S. Siege; et pareillement aux Professeurs de Philosophie d'enseigner les opinions de Descartes".[26] Even more significant was the prohibitive

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[23] C. Du Plessis D'Argentré, op. cit., III, 344-5.

[24] Nouvelles de la République des Lettres, Jan. 1687.

[25] Quaedam recentiorum philosophorum ac praesertim Cartesii propositiones damnatae et prohibitae, Paris, 1705. Cited in F. Bouillier, Histoire de la Philosophie Cartésienne, I, 464.

[26] C. Du Plessis D'Argentré, op. cit., III, 345.

decree issued by the Sixteenth General Assembly of the Oratorians in the same year. From the early 1650s the official Oratorian position was an orthodox one. In 1654, for example, Father Bourgoing, Superior General of the Congregation, circularised the colleges, obliging philosophy professors,"d'enseigner la Philosophie commune et ordinaire et en la maniere qu'elle est enseignée en toutes les Universités de France, afin qu'il ne puisse y avoir parmi eux aucune singularité".[27] Despite such prohibitions, Descartes gained adherents within the Congregation, especially among the young priests and regents. Official condemnation of cartesian doctrine, however, upset the balance of the working compromise. The Lamy affair at Angers and another incident at the Collège du Mans[28] brought home to the Superiors of the Congregation the necessity of capitulation and retribution, especially as they were faced with charges not only of heresy but of political disobedience as well.

The Assembly publicly condemned cartesianism and Jansenism.[29] An order was sent to the various Oratorian colleges telling them

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[27] A.N. Mm 577. Cited in P. Lallemand, Histoire de l'éducation dans l'ancien Oratoire de France, Paris, 1888, pp. 117-8.

[28] A.N. M 230, Affaire du P. Carrier Professeur au College du Mans accusé d'avoir contre les Ordres du Roi, soutenu la doctrine de Descartes - Sa retraction, ses excuses, son exclusion de la Congregation et sa reintegration dus aux demarches du P. du Brueil aupres du Mgr. l'Archêveque de Paris qui fait examiner les cahiers dudit P. Carrier et temoigne de ses bonnes volontés pour la Congregation... Mars 1678.

[29] C. Du Plessis D'Argentré, op. cit., III, 344-5.

what should be taught. It included "dans la physique l'on ne doit point s'éloigner de la Physique, ni des Principes de la Physique d'Aristote, communement reçus dans les Colleges pour s'attacher à la doctrine nouvelle de M. Descartes, que le Roi a défendu qu'on enseignât pour de bonnes raisons...".[30] Père Saillant was chosen to go to Fontainbleau and present a letter to the king explaining the oratory's sentiments in matters of theology and philosophy.[31] A record of Saillant's audience with the

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[30] ibid., p. 344. The order continues:

> L'on doit enseigner,
> 1e Que l'extension actuelle et exterieure n'est pas de l'essence de la matiere.
> 2e Qu'en chaque corps naturel, il y a une forme substantielle réellement distinguée de la matiere.
> 3e Qu'il y a des accidens réels et absolus inherens à leur sujet réellement distingués de toute autre substance, et qui peuvent surnaturellement être sans aucun sujet.
> 4e Que l'ame est réellement presente et unie à tout le corps et à toutes les parties du corps.
> 5e Que la pensée et la connoissance n'est pas de l'essence de l'ame raisonnable.
> 6e Qu'il n'y a aucune répugnance que Dieu puisse produire plusieurs mondes en meme temps.
> 7e Que le vuide n'est pas impossible.
>
> De l'ordre de notre R.P. General et de Son Conseil, le tout ci dessus collatione avec les originaux, par moi, Pretre et Sec. de L'Oratoire de Jesus. J. Pahier.

[31] A.N. M 632 Annales de l'Oratoire, p. 394. For the text of the letter, see F. Girbal, op. cit., pp. 176-7.

king, which took place on the 26th of September, 1678, provides an interesting sidelight on the nature of Louis' opposition to cartesianism. The king, reading the new statutes, came to the article on Descartes and is reported as having said:

> que le Roy avait défendu pour de bonnes raisons - Oui, pour de tres bonnes raisons. Non pas que je veuille empêcher qu'on l'enseigne à Monseigneur mais, je ne veux pas qu'on en fasse un fondement de doctrine... Oui, vous faites bien de ne pas parler de l'etat ni de la monarchie. Votre petit homme d'Angers aurait eu besoin de cet avis.[32]

The muzzling did not end there, for in 1680, according to Fontenelle,[33] the cartesian Pierre Sylvain Régis was forbidden to hold public conferences and a privilege for his book, Système de Philosophie..., withheld till 1688. Spasmodic confirmation of the decision to maintain orthodox doctrine was a characteristic of the deliberations of Paris University till the end of the century and beyond. In 1691, 1693, 1704 and 1705 professors had to sign a formulary denouncing eleven cartesian and Jansenistic propositions supposedly drawn from philosophy courses in 1691.[34] It was not till the reformed statutes of 1720 that Descartes' ideas were officially recognised.[35]

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[32] A.N. Mm 628, p. 140. Cited in P. Lallemand, op. cit., p. 126.

[33] Oeuvres de M. de Fontenelle, nouv. édit., Paris, 1758, V, 149.

[34] C. Jourdain, Histoire de l'Université de Paris, pp. 269-70, and Pièce Justificatif CXLIX, pp. 129-53.

[35] ibid., Pièce Justificatif, CLXVII, art. XXII, p. 173.

Such repeated actions by the University of Paris, royal authority and the religious orders would suggest that the persecution was a failure. It might be argued that there was a wide gap between theory and practice, between enactment and execution. Its success or failure, however, is not under discussion. Repeated attempts at censorship were enough to cause consternation in the cartesian camp and so to influence Rohault.

In assessing the reasons for condemnation, difficulty arises because of the espousal of cartesianism by a number of reforming theologians. The door is thus opened to the confusing intricacies of church politics. Can the persecution be seen primarily as an attack by Jesuit scholastic theologians on their opponents who used the new philosophy to bolster their neo-Augustinianism, or are there equally important factors to be considered? Is it possible, for example, to see the opposition of the University of Paris as that of an institution jealously guarding its privileges against the encroachments of a fashionable, new and progressive learning; or again, to see royal opposition as the irrevocable decision of a king intolerant of any form of dissidence?

Paul Mouy has argued that, in France, proscription was by the temporal power and directed against cartesian physics.[35a] François Bouillier, on the other hand, held that it took place on basically religious grounds.[36]

[35a] P. Mouy, La Physique Cartésienne, p. 170.

[36] F. Bouillier, Histoire de la Philosophie Cartésienne, I, 430-72.

It must be remembered that Descartes' concept of 'philosophy' was an organic whole. He stressed this in his famous tree metaphor in the preface to his Principes. He wrote,

> Ainsi toute la Philosophie est comme un arbre, dont les racines sont la Metaphysique, le tronc est la Physique, et les branches qui sortent de ce tronc sont toutes les autres sciences, qui se reduisent à trois principales, à sçavoir la Medecine, la Mechanique et la Morale...[37]

Furthermore, in a society where the Church exerted a strong influence on men's lives from the cradle to the grave, it was natural to examine the theological implications of cartesian philosophy. Hence, for example, it was possible to see in Descartes' definition of matter as extended substance a threat to the dogma of the Eucharist where it was necessary to have the accidents of the bread and wine really distinct from their substance in order to explain transubstantiation.

Secondly, the temporal power played an important role in the persecution but it did so for politico-ecclesiastical reasons. Many Jansenists, like Arnauld and Nicole, opponents of Louis XIV's church policy, were attracted by the harmony which existed between Descartes' teachings and those of St. Augustine. Hence Louis saw those, who, in the early years of his personal reign, refused to sign the Formulary and who later opposed his right of Régale as Jansenist-cartesian heretics not only threatening his kingdom with schism but jeopardising his policy towards Rome.

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[37] O.D., IX-2, nouv. prés., p. 14.

While these were the principal reasons for persecution, the conflict can be seen in terms of orthodoxy versus dissent. The religious orders, faced with the double charge of religious and political heresy, were quick to emphasise their orthodoxy and loyalty. The king, in accordance with divine right theory, felt it was as much his prerogative to control intellectual speculation as it was to lead his armies, especially when that intellectual speculation threatened to disturb the tranquillity of his subjects. The universities, who gave much of the original impetus to interdiction, felt that their whole system of education was being undermined by a new philosophy which could not accommodate itself with Catholic dogma.

Finally, the optimism and aggression of some of the cartesians themselves helped confirm their opponents in their belief that the attack on Aristotelian philosophy and Thomist theology, for the sake of unity and peace, had to be resisted as vehemently as possible.

In the period before Rohault's death, Claude Clerselier was especially noted for his vigorous campaign to gain acceptance of Descartes' interpretation of the Eucharist. With him must rest part of the responsibility for Descartes' condemnation by the Index in 1663 and for the severe reprimand which he, Rohault and Desgabets received from the Archbishop of Paris in 1671.[38] The pursuit of

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[38] Bib. Municipale de Chartres, Mss. 366, fol. 327. Volume 366 was severely damaged in 1944. This reference was cited in P. Lemaire, Le Cartésianisme chez les Benedictins, Thèse, Paris, 1901, pp. 129-32.

his plans to publish what Descartes had written on the Eucharist, what he called "le dernier travail auquel je me destine pour mettre fin a tous les ouvrages de Mr Descartes",[39] was conducted with such naivety and aggression as to invite censorship. In 1660, Dom Antoine Vinot advised him not to correspond with the Jesuit Père Jean Berthet:

> ...vous ne pouviez donnez un attente plus mortelle à la philosophie de Mr Descartes ni a la reputation de sa personne qu'en communiquant vos pensées et vos escrits sur la matiere de l'Eucharistie a ces gens là... croyez une fois pour toutes qu'ils quitteront plutot et la robe et le bonnet que la Philosophie d'Aristote qui est l'unique fondement de la Theologie scholastique laquelle est le fond principal de la société et comme le Tresor sur lequel ils ont toujours les yeux ouverts...[40]

Early in 1664, after the private censures of Malleval and Fabri, Vinot wrote with bitter self-satisfaction to Clerselier telling him of Descartes' condemnation by the "Inquisition of Rome",

> ...il faut que ce soit la matiere eucharistique qui ait esté le pretexte des Censures. Vous voyez comme j'ay esté prophete vous ayant dit il y a longtemps que le commerce que vous aviez avec le P. Bertet produiroit quelque chose de funeste a la Philosophie du grand Maistre. Le P. Fabri envoya une Censure privée et il en a procuré une publique.[41]

Undaunted, Clerselier, in alliance with Dom Robert Desgabets, continued his earnest promotion of Descartes' ideas on the Eucharist. Their correspondence with various members of the Church, discussing in detail, answering objections, calling for support,

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[39] Chartres 366, Clerselier à Bertet, 27 Aout 1659.

[40] ibid., Vinot à Clerselier, 1660.

[41] ibid., Extrait d'une lettre de Vinot à Clerselier, 1664.

explaining their position, ran to over a thousand octavo pages. In 1671 a rising wave of opposition broke on their heads. One of Desgabets essays, Considerations sur l'estat present de la controverse touchant le St. Sacrement de l'autel,[42] was printed without his consent. Louis XIV was given a copy by his Jesuit confessor, P. Ferrier, who told him, "c'estoit un livre heretique et tres pernicieux".[43] The king in turn gave it to the Archbishop of Paris to have it "examined and censured".[44] In September, Descartes' doctrines were condemned by royal authority and the University of Paris. In December, Millet du Pertuis published Rohault's Entretiens and created further uproar. On Christmas Eve, the Archbishop of Paris told Clerselier he must bring his campaign to an end.

In a letter to Desgabets, Clerselier gave an account of his meeting with the Archbishop. He wrote,

> Il me dit donc que sa Majesté, ayant apaisé les derniers troubles qui s'étaient mis entre les théologiens sur des questions difficiles et épineuses, et ayant par ce moyen, mis la paix et la tranquillité dans son Etat, il désirait la conserver, et voulait empêcher qu'une pareille contestation ne s'élevât encore parmi les savants, laquelle, sous pretexte d'autres sujets, pouvait réveiller les mêmes disputes, ou en faire naître d'autres, qui pourrait, dans la suite, causer des divisions et des troubles dans son royaume, et ainsi ruiner l'effet et tout le fruit de ses soins;

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[42] Reflexions pour la Justification de l'Escrit 'Ad Hominem' contre messieurs de Port Royal Intitulé considerations sur l'estat present de la Controverse touchant le St. Sacrement de l'autel.

[43] Chartres 366, Desgabets à Clerselier, 24 Sept. 1671.

[44] loc. cit.

> et comme le philosophe M. Descartes sembla alarmer les savants, et jeter les semences d'une division qui pourrait a la fin s'allumer, s'il n'y était pourvu de bonne heure, Sa Majesté ayant appris que M. Rohault, mon gendre, et moi étions des principaux de ceux qui pouvaient la faire valoir et la défendre, il me dit qu'il avait ordre de me dire que nous eussions dorénavant à nous contenir, pour ne rien faire qui pût éclater et animer contre nous ceux du parti contraire; et, qu'en son particulier, il me priait de le faire trouver véritable, et de ne pas démentir la parole qu'il avait donnée au roi que je satisferais pontuellement a ses ordres...[45]

Whatever might be said of Clerselier's blind pursuit of his plans, or whatever consequences they may or may not have had, he was at least tactful enough to restrict his campaign to private correspondence. When Desgabets, in 1671, urged him to publish what he had written, Clerselier replied that the time was not yet right.

> Les esprits ne me paraissent pas assez bien disposés, ni les choses assez mûres, ni assez préparées pour oser entreprendre de la proposer. Je puis pourtant vous dire qu'il y a tout plein d'honnêtes gens, à qui cette maniere d'expliquer le St. Sacrement n'est pas incomnue, qui le goûtent et qui en parlent, et même devant les jésuites, qui la leur soutiennent en face.[46]

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[45] Chartres 366, Clerselier à Desgabets, ou il rend compte de ce qu'il avait fait pour lui aupres de M. l'archeveque de Paris, 24 Decembre 1671, fol. 327. See P. Lemaire, loc. cit.

[46] Chartres 366, Clerselier à Desgabets, fol. 412. Cited in P. Lemaire, op. cit., p. 260. Lemaire also cites Epinal, Mss. 142, Clerselier à Desgabets, p. 273:

> D'espérer que de vieux docteurs puissent revenir de leurs sentiments et entrer dans de nouvelles pensées, c'est ce que je ne puis croire...Cela ne se doit attendre qu'après un siècle, où les vieux de ce temps-là ayant été jeunes de ce temps ici se trouveront imbus de nos principes et ne seront plus effarouchés de la nouveauté.

Dom Robert Desgabets was as eager as Clerselier to make respectable the theological implications of Descartes' philosophy. But the result was an interrogation by his superiors and a promise of submission to their demands of silence.[47]

The response to censorship by other cartesians ranged from capitulation to confidence in the total triumph of their philosophy. Père Nicolas Poisson of the Oratory, correspondent of Clerselier, Desgabets and Rohault and commentator on Descartes' Discours, Abrégé de la musique and Traité des Méchaniques,[48] wrote of the condemnation by the Theological Faculty of Louvain, "on sçait assez comment se fait ces sortes de condamnations; et sans reveler le secret, je pourrois citer mille exemples de condemnations faites plûtot par vengeance ou par opiniâtreté que par justice avec raison".[49] Poisson, however, was deprived of his self-appointed role as commentator on all the works of Descartes by the Superiors of his congregation. On the 13th of June, 1670, the Conseil de

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[47]Chartres 366, Desgabets à Clerselier pour presenter a Mr L'Archevesque de Paris François de Chanvalon avec l'Interrogation qui luy fut faite en presence de ces Superieurs a l'occasion de l'escrit cy dessus, de Breuil, 10 Decembre 1671. Desgabets terminates the letter:

> ...,mais connoissant la volonté de ses superieurs, Il se soumet tres volontiers a n'y plus penser et a n'en plus parler et escrire a personne, ce qu'il observera Dieu aydant cy apres avec une entiere fidelité.

[48]Commentaire, ou Remarques sur la Méthode de René Descartes..., par L.P.N.I.P.P.D.L., Vandosme, 1670; R. Descartes, Traité de la Méchanique et l'abrégé de musique avec des éclaireissements nécessaires Par N.P.P.D.L., Paris, 1668.

[49]R. Descartes, Discours de la Méthode. Contenant la Méthode et la Méchanique. Nouvelle Edition augmentée des remarques du P. Poisson Prêtre de l'Oratoire, Paris, 1724, p. 387.

l'Oratoire ordered "Le Pere Nicolas Joseph Poisson ne donnera point au public son ouvrage sur Mr Descartes...",[50] but as this was too late to prevent publication, another command was made on 18th July,

> P.N.J. Poisson il luy est permis de venir à Paris pour ses affaires et apportera avec luy tous les exemplaires qui ont esté imprimés de son ouvrage sur Mr des Cartes pour les remettre au Reverend P. General et a son conseil.[51]

Later, Poisson confessed,

> ...comme ceux à qui ma condition m'oblige d'obéir, et aux ordres desquels je dois toute sorte de soumission, m'ont donné quelque avis sur ce sujet; je déclare encore que je ne prétens aucunement défendre non-seulement ce que l'Eglise, mais même ce que les moindres Universités auroient condamné.[52]

Mr Le Prince, critic of Rohault's <u>Entretiens</u>, wished that Rohault "eust foudroye l'Ecole comme il feroit luy-mesme une ville rebelle, en sorte qu'il n'y eust ny bar ny chaise qui ne fust renversé".[53] Millet du Pertuis castigated the "meaningless language of the self-perpetuating Schools"[54] but added the qualification that Descartes

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[50] A.N. Mm 581, Registres des Ordres et Deliberations du R.P. General de la Congregation de l'Oratoire...1669-73, fol. 14.

[51] A.N. Mm 581, ibid., fol. 16^{vo}.

[52] Descartes, <u>Discours</u>...remarques du P. Poisson, 1724, Avis, p. 480 (not pag.).

[53] Chartres 366, Clerselier à Desgabets ou il luy rend compte de ce qui se dit a Paris à l'occasion des disputes sur le St.Sacrement?

[54] J. Rohault, <u>Entretiens sur la Philosophie</u>, Preface, not pag.

was very much in accord with Aristotle. They differed only where new inventions and experiments had shown Aristotle to be wrong. René Fédé, a fervent disciple of Descartes, doctor of the Angers Medical Faculty and later 'Mayor' of Châteaudun, outspokenly defended Descartes in the preface to his 1673 edition of Les Méditations. Confident that time and the solidity of the doctrines would prove Descartes' value, he made a vigorous attack on the "malice de quelques envieux", who with "miserables obiections qui sont plus digne de pitié que de response...attaquent sa personne par des calomnies pour rendre sa doctrine suspecte et odieuse". "Que puisque", he wrote, "Mr Descartes n'a jamais pretendu plaire qu'aux honnestes gens; et aux personnes judicieuses, on ne veut pas se mettre en peine de luy procurer l'approbation de ceux qui ne sont pas de ce nombre".[55]

As we have noted above, Descartes was attacked because he threatened theological orthodoxy and the peace of the kingdom. The Angers University authorities later complained indignantly of the cartesians,

> On n'apprenoit plus aux jeunes gens qu'à douter de toutes choses, même de leur existence;...ils ont moins besoin de Maîtres qui leur apprennent ce qu'ils n'ont jamais sçu que de moniteurs qui rappellent dans leur Esprit les anciennes idées de toutes choses... Il n'y avoit point de forme substantielle outre l'âme raisonnable, point d'accidens réellement distingués de leur substance.

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[55] R. Descartes, Les Méditations métaphysiques..., Par R.F., 3[e] édit., Paris, 1673.

> L'essence de tous les corps consiste dans l'extension locale, sans prendre garde que celuy de J.C. n'en a point dans l'Eucharistie; ...Leur Doctrine étoit encore injurieuse aux Souverains et tendoit au renversement de l'Etat politique.[56]

As we have noted too, reactions to these charges on the part of cartesians varied widely. The fact, however, that cartesians were obliged to answer these charges is often overlooked. Characteristic of their defence was a readiness to meet their opponents on their own grounds by entering the realms of theological debate. Where they differed was over the problem of what tactics to employ. Some, like Clerselier, were prepared to deny the charges head on, emphasising the harvest of advantages to be reaped from cartesian doctrines. Others, like Père René Le Bossu, adopted a much more conciliatory tone and attempted to reconcile Descartes with Aristotle. Both attitudes are evidence of the reality of persecution.

In 1669, Le Bossu, a zealous admirer of cartesian physics, lamented that "overzealous friends of Descartes"[57] were provoking censorship by spreading Descartes' sentiments on the Eucharist before his physics were better understood and received in the universities.[58] He argued that some sort of accommodation must be

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[56]Angers 1253, C.G. Pocquet de Livonnière, op. cit., pp. 233-68. Cited in F. Girbal, op. cit., p. 137.

[57]"...des Amys trop zelez de Mr Descartes". Bibliothèque Victor Cousin, Mss. 94, Le Bossu à M. Estienne, contenant une maniere dont on pouroit proposer la Physique de M. Des Cartes, escrite au sujet des sentimens de cet Autheur sur l'Eucharistie, A Chartres le dernier jour de janvier 1669, p. 7.

[58]Cousin, 94, p. 5.

provided between Descartes and Aristotle. Why not, he said, retain the old terminology in order to get the learned doctors "d'ecouter plus paisiblement et d'examiner avec tranquillité ce qu'on leur propose".[59] But during the next few years he pursued his plans for reconciliation to the point where he failed not only to prevent censorship but also to keep clear in his own mind the differences between Descartes, Aristotle and Epicurus.[60]

Clerselier, on the other hand, maintained that Descartes' interpretation of the Eucharist, far from being heretical, was in the tradition of St. Augustine and the Church Fathers; that, far from threatening dogma and peace, it provided a more satisfactory explanation which could be used to win over Protestants and reconcile the Roman and Eastern Churches.

Clerselier's defence went farther than conducting a debate by correspondence with various priests. By his own example of piety, he sought to place his beliefs beyond reproach.[61] Through his prefaces to Descartes' Lettres, his part in the 1667 celebrations and the mustering of his friends to help him, he mounted a crusade

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[59] Cousin, 94, p. 14.

[60] See Bib. V. Cousin Mss 94 and 96 and Chartres Mss 612.

[61] Nouvelles de la République des Lettres, I, 2[e] édition, Amsterdam, 1686, Juin 1684, p. 433, Extrait d'une Lettre écrite à L'Autheur de ces Nouvelles touchant M. Clerselier:

> Il faut pourtant avoüer qu'on peut être bon Catholique et bon Cartésien en même temps, car je ne croy pas qu'il y eût aucun Bourgeois dans Paris qui allât plus souvent a la Messe que le bon M. Clerselier.

to put not only the doctrines but the personnage of Descartes beyond any charge of atheism or libertinism.

In 1663, in the preface to the second edition of the first volume of Descartes' Lettres, Clerselier stressed the sanctity of Descartes' death in Sweden. In 1666, in the preface to volume three, he made a more positive statement of his own involvement with Descartes' defence. Reject all of Descartes' physics if you will, he wrote, but do not believe that he forsook his faith or that his doctrine was morally dangerous.

> ...ce que je ne puis souffrir sans quelque sorte de colere et d'indignation, ou du moins sans me plaindre, est de voir qu'impunement on accuse sa doctrine de favoriser en quelque façon les libertins et les athées.
>
> Sans mentir, c'est traitter cruellement un Philosophe qui a sappé les deux principaux fondemens du libertinage et de l'atheisme, en prouvant invinciblement l'existence de Dieu et l'immortalité de nos Ames, et qu'on peut dire avoir mieux merité par là qu'aucun autre de la Religion, que de luy faire de semblable reproches. Que l'on dise ce que l'on voudra de ses principes de Physique, mais qu'on ne touche point à ses moeurs; qu'on se raille de ses opinions, mais qu'on épargne sa personne; qu'il soit permis, à la bonne heure, de traitter d'extravagance ses petites globes et sa matiere subtile; que l'on croye, si l'on veut, qu'il fallait que la cervelle qui tournast, quand la pensée est venue de placer des tourbillons dans le Ciel et d'en égaler le nombre a celuy des Estoilles; que l'on considere comme un jeu de marionnettes et comme des tours de passe-passes le mouvement du coeur, la circulation du sang, les diverses agitations du glande, ou le cours et la distribution des esprits animaux qui en dépend: tout cela est de peu d'importance, pourveu qu'on ne luy fasse point cette injure de croire qu'il a chancelé dans sa Foy, qu'il a esté aussi inconstant dans sa Religion que la pluspart des Philosophes le sont dans leurs opinions, et que son coeur n'a pas

> répondu à ses paroles... Que l'on dise toutes ces choses, et qu'on traitte tout ce qu'il a fait de chymere et de fable, je laisserey tout dire et ne m'y opposeray point, pourveu qu'on n'accuse pas ny luy ny sa doctrine de pecher contre la Morale et d'estre dangereuse pour les moeurs...62

In 1667, arrangements were made for the reburial of Descartes in the University church at Ste. Geneviève du Mont. Sainte Geneviève, which Baillet called "the sanctuary of Religion and the Sciences",[63] was chosen "...non seulement à raison de ses prerogatives, mais encore a cause qu'elle est située au milieu des Lettres et de l'Université".[64] Supplications and testimonies to Descartes' catholicity, "l'integrité de ses moeurs et l'innocence exemplaire de sa vie",[65] were presented to the Reverend Père François Blanchart, abbot of the church and Superior General of the Congregation of France. Blanchart gave his permission for the burial to take place and promised to conduct the funeral service. The service, celebrated with pomp and ceremony, took place on the 24th and 25th of June.[66]

These celebrations, on the one hand, were designed to glorify Descartes and his philosophy, and on the other, were a blatant answer to the threats of persecution. Descartes' body was carried to the heart of the enemy's camp. Pierre Lallemant, Chancellor of

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[62] O.D., V, 641-2.

[63] O.D., XII, 594-605, after Baillet, Vie de Descartes, II, 439.

[64] O.D., XII, 600, Relation de ce qui s'est passé en la Congregation des Chanoines Reguliers de France en l'année 1667.

[65] Baillet, op. cit., II, 441. Cited in O.D., XII, 603.

[66] Baillet, op. cit., II, 439ff. See also, Bib. Ste. Gen. Mss 662 fol. 113 and Mss 2564 fol. 52.

the University, was chosen to sing the philosopher's praises. Declarations by Père Viogué, Pierre Chanut and his sons, Claude Clerselier and Queen Christina bore witness to Descartes' piety and orthodoxy.[67] Queen Christina certified that Descartes

> ...a beaucoup contribué à nostre glorieuse conversion, et que la Providence de Dieu s'est servi de luy, et de son illustre amy le sieur de Chanut, pour nous en donner les premieres lumieres, que sa grace sa misericorde acheverent apres, a nous faire embrasser les veritez de la Religion Catholique, Apostolique et Romaine.[68]

Clerselier swore that Descartes, in his works, correspondence, speech and way of life, had shown reverence for and faith in the Catholic church and religion. He had submitted to the authority of the Holy Church, kept religious feasts, had frequently taken the sacrements and had died as he had lived, close to the bosom of the Roman, Catholic and Apostolic Mother Church.[69]

Rohault's reaction was neither as conciliatory as that of Le Bossu nor as aggressive as that of Clerselier. He resented and was embittered by "l'iniustice et...la malignité des hommes" which, he said in a letter to Poisson, "il faut tacher de ne pas irriter".[70] Clerselier wrote to Desgabets on the subject of his son-in-law's Entretiens sur la Philosophie,

> Vous avez raison de dire que Mr Rohault a un peu braisé quand il a parlé de la nature de la matiere ou de l'estendue, il a eu peur de se faire des affaires et il a mesme esté besoin que je luy aye soustenu le

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[67] Baillet, op. cit., II, 441. See also Bib. Ste. Gen. Mss 662 fol.112.

[68] O.D., XII, 600-1, Relation...

[69] Bib. Ste. Gen. Mss 3534, Clerselier's Attestation of Descartes' orthodoxy, 23 April, 1667, fol. 3.

[70] Honfleur Fonds Adry (15 II) 4 fol. 34.

> courage pour en parler dans toute la force qu'il a fait. S'il eust ozé suivre entierement mon avis il se [seroit] purement laissé conduire par la lumière naturelle sans rien pallier ni déguiser. Mais il a pensé qu'estant un [homme] public sur qui l'on jettoit les yeux et dont toutes les paroles seroient relevées pour peu qu'on y trouvast a mordre, Il a cru qu'il estoit plus expedient d'en parler comme il a fait c'est a dire d'une maniere qui sans rebutter ni choquer personne ne [laisse] pas de decouvrir assez la verité et de l'insinuer doucement dans les esprits.[71]

Rohault seems to have been of a more timid disposition, or more tactful, than his two friends, Clerselier and Desgabets. Nevertheless, in his Lettre à Guyard and his Entretiens, he rose to defend, with resolute sobriety, his own Traité and Descartes' interpretation of the Eucharist and doctrine of the beast-machine.

Before assessing the influence of persecution on Rohault it is important to review the chronology of events. Prior to January 1671, when the Traité was published, Descartes' philosophy was censored by Fabry and Malleval (1660 and 1663), by the University of Louvain (1662) and by the Congregation of the Holy See (1663). In 1664 and 1666 the University of Paris stressed the necessity of founding its Arts' courses on the philosophy of Aristotle. In 1667 Lallemant was prevented from delivering his eulogy at the funeral service celebrating Descartes' reburial. In 1670 the Conseil de l'Oratoire prohibited the sale and distribution of Poisson's commentary on Descartes' Discours de la Méthode. Cartesians such as Poisson, Clerselier, Desgabets and Le Bossu manned the bastions to defend their master's philosophy as they saw fit.

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[71]Chartres 366, Clerselier à Desgabets.

The first wave of censorship did not reach its full height till 1671. In mid-1671 Desgabets' Considerations... was printed, which, despite explanatory letters from Desgabets and Clerselier to their correspondents,[72] led to condemnation by Arnauld, Nicole and the Archbishop of Paris. On the 10th of June, 1671, Rohault defended his philosophy in a "Lettre à Monsieur Guiard" by attempting to answer the principal objections of the Doctors of the Sorbonne. (On the 5th of December, an expanded and more polished version of the "Lettre" was published by Millet du Pertuis under the title, Entretiens sur la Philosophie.) In September, cartesianism was condemned by the University of Paris and on Christmas Eve, Clerselier was informed by the Archbishop of Paris (François de Chanvallon), that the king wished that he and Rohault "eussions dorénevant à nous contenir".

The siege mentality of cartesians during the period 1663 to 1672 helps explain the changes in Rohault's attitude to the work of Aristotle. In 1660 Rohault was forthright in his criticism of Aristotle's concept of matter. By 1671, in his Traité de Physique and Entretiens sur la Philosophie, he had adopted a much more conciliatory attitude. Threatened with censorship and with the objections of pro-Aristotelian interpreters of the Eucharist, he reacted in a tactful fashion. He stressed his respect for Theology which he regarded "comme la Reine des Sciences et à laquelle j'estime

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[72]ibid., letters to M. Arnauld, M. Claude and l'Evesque de Condom, 23 August and 5 Sept. 1671.

toutes les autres se doivent sousmettre",[73] and his belief "qu'au Saint Sacrement de l'Eucharistie toute la substance du pain est convertie et transubstantié au corps de nostre seigneur Jesus Christ et de mesme que toute la substance du vin est convertie en son sang".[74] Moreover, he was inclined to look for places where his philosophy agreed with Aristotle. This change can best be demonstrated by looking at Fedé's record of Rohault's conferences in 1660, the <u>Traité de Physique</u> and the <u>Entretiens</u>.

Fedé stated that, at a conference on the 15th of December, 1660, Rohault outspokenly criticised Aristotle's concept of matter.

> Monsieur Rohault a dit Apres avoir estably l'essence de la matiere, Il n'est pas besoin de refuter la pensée d'Aristote, quj la definit, ce quj n'est ny la grandeur ny la qualité etc. mais le commun faict de toutes ces choses. Cette proposition se destruit d'elle mesme, puisque quoiqu'elle soit vraie, elle ne nous apprend de ce qu'est la matiere, mais nous fait sçavoir ce qu'elle n'est pas; or nous cherchons autre chose, et ainsy nous n'avons pas lieu de nous satisfaire d'une responce quj elude nostre demande, et ne l'esclaircit pas; Adioustez que cette definition pretendue estant illusoire en soy mesme est encore inutile dans sa suitte, puisque l'on n'en tire aucune consequence; Ce quj ne se peut dire de celle que l'on a apporté cy dessus lorsque l'on a dit que cestoit un estre estendu.[75]

By 1671, Rohault, in his <u>Traité</u>, while still pointing out what he felt were the weaknesses in Aristotle's work, was ready to draw parallels between cartesian and Aristotelian physics: "I have taken

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[73]B.N. F.Fr. 17155, fol. 293.

[74]ibid., fol. 295.

[75]Bib. Ste. Gen. Mss. 2225 fol. 10.

all the general Notions from Aristotle..."; [76] Aristotle "concludes that there are three principles of natural things, Privation, Matter and Form ... we conclude, that there is but two principles of natural things, viz. Matter, and Form"; [77] Aristotle "expressly distinguishes between Extension and Quantity, as everyone ought, because we can conceive the one without the other... Now in this sense of the word Matter, there is no Inconsistency in saying that it may be extended, and yet not be anything that will answer to those Questions which Aristotle there enumerates; for those Questions are to be understood only of Matter under some particular Forms". [78] By the end of 1671, when the threat of censorship was even greater, Rohault was all the more obsequious and writing in his Entretiens,

> Je n'ay point d'autres principes que ceux d'Aristote, ie reconnoist avec lui la privation, la Matiere et la forme, je conviens des notions generales qu'il nous donne de la substance et de l'accident, je n'entens autre chose que luj par les mots d'essence et de qualité, je reiettes le vuide aussi bien que luy, et bien loin y d'admettre les atomes insecables d'Epicure, je demonstre que la matiere est divisible a l'infiny. [79]

It is distortion, however, to stress only the increasingly conciliatory stand taken by Rohault on the subject of agreement or disagreement with Aristotle. He was able to reach a compromise and to avoid betraying his own principles by arguing that he valued the

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[76] Rohault, System, preface, not pag.

[77] ibid., I, 6, 22.

[78] ibid., I, 7, 25.

[79] B.N. F.Fr. 14837 fol. 240.

philosophy of Aristotle "en faisant voir qu'en suivant sa Doctrine, et s'escartant seulement de la Methode, qui est en usage la quelle il condamne luy mesme, on a fait la descouverte d'un tres grand nombre de choses dont il ne paroist pas qu'on ait eû connoissances avant ce siècle icy,..".[80] He and Aristotle agreed on general principles but his own 'descent to particulars' enabled science to take a step forward. Such an attitude squared neatly with his belief in the progress of the sciences. Similarly, the cartesian interpretation of the Eucharist was better than the Aristotelian, since it enabled him to know positively that transubstantiation of bread and wine was possible, whereas the schoolmen could only lead him to a position of not knowing that transubstantiation was impossible.[81] In other words, Descartes' work did not contradict the work of Aristotle but it was nonetheless superior.[82]

It might also be claimed that Rohault's particularist approach to natural philosophy, his apparently modern position of concentrating on physics rather than metaphysics, was a result of the threat of persecution. In the Traité Rohault said,

> ...I expressly declare, that my Design is to consider Things in their ordinary and natural State... And above all things, I particularly guard my self against enquiring into the Mysteries of Faith, and attempting to explain what is obscure therein; because I am firmly perswaded, that that which God Almighty would have to be a Mystery to the Ignorant and Unlearned, he would have to be so likewise to the most exalted Genius...[83]

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[80] ibid., fol. 286 and Rohault, Entretiens, pp. 207-8.

[81] B.N. F.Fr. 14837 fols. 246-7.

[82] cf. B. Pascal, Preface to the Treatise on the Vacuum, Great Books, 33, 355-8.

[83] Rohault, System, I, 5, 20-1.

The same argument was used in his Entretiens, in a passage which shows that, in writing his Traité, he was conscious of the need for tact.

> ...la faculté de théologie ne se mesle que des choses qui regardent la foy, et ie pretend avoir pris toutes les precautions nécessaires pour ne pas manquer de ce costé-là; car non seulement je n'ay pas traité des questions qui regardent en quelque façon que ce soit les Mysteres de la foy, mais je me suis mesme abstenu d'en toucher aucunes de celles, ou les Philosophes prenent la liberté de decider du pouvoir de Dieu, de sorte que pour ne pas faire un autre personnage que celuy de Physicien j'ay seulement traité des choses comme elles sont en leur estat ordinaire et naturel comme j'ay fait d'abord une declaration bien expresse que j'ay mesme eu soin de repeter deux ou trois fois selon l'occasion s'en est rencontrée ou j'ay dit que je laissois au Theologiens a nous dire les choses pourraient estre dans un estat extraordinaire et surnaturel.[84]

While these declarations seem to have been provoked by the threat of persecution, we cannot fully explain by this means either Rohault's preference for physics or his interest in experimentation. The latter, as we have seen elsewhere, was much influenced by the contemporary European experimental movement, Rohault's own inclination and his interpretation of Descartes. It is possible, nonetheless, that persecution helps explain the brevity with which a particular type of metaphysical argument (eg. the ontological one) is treated in his Traité de Physique.

During the last years of his life Rohault became involved in a time-consuming campaign to win acceptance for the 'new philosophy'. Anticipating censorship of his work by the Theological Faculty, he attempted to evade it by visiting the Sorbonne, collecting

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[84] B.N. F.Fr. 14837 fol. 239 and Rohault, Entretiens, pp. 9-10.

objections and publicizing his answers in the "Lettre à M. Guyard" and Entretiens sur la Philosophie. According to the "Lettre" M. Guyard, Syndic of the Sorbonne, asked Rohault to write to him and give an account of his meeting with Guillaume Lestoc, a Doctor in Theology at the Sorbonne.[85] Millet du Pertuis, in his preface to the Entretiens, informs us that Rohault was careful

> de consulter plusieurs fois les plus renommez d'entre ceux qui desapprouvent cette Doctrine [Descartes'], et qui en ont mesme poursuivis la condemnation par bien des sortes de voyes: Il a recüeilly toutes leurs objections, et principalement celles qui regardent la croyance que nous avons du St. Sacrement de l'Eucharistie: Mais a tout ce qu'ils disent, il répond d'une maniere si nette, et si précise, que si jamais leur credit n'est plus fort que leur raison, il n'y aura rien à craindre.[86]

The "Lettre" and the Entretiens have a similar format and purpose: a discussion with Mr N. (Guillaume Lestoc) defending cartesian philosophy. Mr N. is portrayed as the epitome of what Rohault would like a university doctor to be; open-minded and rational in his search for the truth, and of course, easily convinced by Rohault's arguments. Rohault denied the charge thatthe new philosophy threatened the dogma of the Eucharist. He defended himself by arguing that his way of explaining the 'how' of transubstantiation, while differing slightly from that of the Schools, did not contradict, to the best of his knowledge, the ruling of any Council.

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[85] B.N. F.Fr. 17155 fol. 292.

[86] Rohault, Entretiens, preface, not pag.

Although not everyone was satisfied with Rohault's answer, the Entretiens attempted to defend more than Descartes' interpretation of the Rucharist. It tried to explain the relationship between cartesian and Aristotelian philosophy, to defend Descartes' doctrine of the beast-machine, and to answer the objection that "the new philosophy" was "nothing other than the philosophy of Epicurus",[87] and thus prevent censorship of Rohault's own Traité de Physique. Asked by Mr N. what he thought of the possibility of his Traité being censored by the Sorbonne, Rohault answered that there were a large number of moderate and prudent professors who knew that Descartes' principles had been abroad for more than twenty-five years. Besides, he had purposely refused to meddle with theological affairs.[88] By the end of the Entretiens Mr N. is a convert to Rohault's way of thinking. He assures Rohault that there should be nothing to impede his way of philosophizing for he attacks no one but tries only "d'establir le verité sans insulter a qui que ce soit".[89] His opinions are well received and approved by the majority of "honnestes gens" and "personnes d'esprit" and most important of all, they conformed to the mysteries of the Catholic faith.

Like Clerselier, Le Bossu and others, Rohault was obliged to defend Descartes' philosophy by meeting his opponents on their own

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[87] see B.N. F.Fr. 14837 fols. 283-5 and Rohault, Entretiens, pp. 196-206.

[88] B.N. F.Fr. 14837 fols. 238-9 and Rohault, Entretiens, pp. 6-10.

[89] B.N. F.Fr. 14837 fol. 288.

grounds of metaphysical and theological dispute. His concern, however, and the fact of Descartes' condemnation bear witness to the strength of Aristotelian philosophy in mid-seventeenth century France. Clerselier's attempt to gain adherents in the religious orders, and Rohault's to win support in the University of Paris, show that for first generation cartesians the conflict within church, state, universities and religious orders was real. Rohault, in his _Traité_, cautiously presented Aristotle and Descartes as allies, not enemies, and avoided prolonged analysis of metaphysical questions. Reluctantly, he was drawn into and embroiled in what was primarily a theological dispute. From this stemmed several disadvantages, not the least of which was neglect of his first love, physics.

CONCLUSION

Though his Traité de Physique coherently described the achievement of the Scientific Revolution before Isaac Newton, Rohault nonetheless remains a minor figure in the history of science. In the Traité, two theoretical systems, the Aristotelian and the cartesian, were joined in an uneasy alliance which described the continuing progress of the natural sciences. The experiments and observations of Galileo, Cassini, Pascal, Huygens and Rohault himself, supported and extended a synthesis of Descartes' work in physics. Rohault strengthened his arguments with numerous mechanical examples drawn from his experience of the techniques of artisans and craftsmen. But his failure to be severely critical of the cartesian system and to follow closely his own methodological prescription for the sciences reduced the potency of his work.

To condemn Rohault for lacking the creative genius of a Descartes or a Newton, however, is to misinterpret his position in the French scientific movement. In Parisian polite society of the 1660s, at a time when science was fashionable, Rohault was the ablest exponent of cartesian physics, the organizer of public conferences which widened and heightened the appeal of cartesianism generally.[1] He had the teacher's ability to impart knowledge lucidly and succinctly and an experimental dexterity which enabled

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[1] As a propagandist of the 'new philosophy', he is most properly compared with other 'conférenciers' like De Launoy, J.B. Denis and the Abbé Bourdelot.

him to describe and illustrate cartesian physics with unrivalled force. Yet it cannot be asserted that, as a result of his conferences cartesianism rapidly permeated all levels of Parisian society. Whatever appeal an ambiguous cartesian spirit may have had among 'gens du monde', cartesian physics was far from being accepted by the élite of the scientific world by the time of Rohault's death in 1672. Nor was he the only master of the Parisian school of cartesian propagandists. He shared the responsibilities of leadership with his father-in-law, Claude Clerselier. In the end, his greatest achievement, even as a propagandist, was his Traité de Physique, which eventually became a hand-book for students of the 'new philosophy'.

One of the principal objects of this study has been to identify the major influences on Rohault's work in the natural sciences. Despite the fact that these influences often overlap and occasionally are based only on inference, they are the key to understanding Rohault's career. His family background, his education at the University of Paris, his relationship with craftsmen, conversion to cartesianism, acceptance by the Parisian scientific community, his professional interests as a mathematics teacher, friendship with Clerselier and the persecution of cartesianism are essential to an evaluation of his work.

By far the greatest single influence was René Descartes. The driving force and success of Rohault's conferences came from their elucidation and promotion of Descartes' physics. Even Rohault's cautious attempt to deal with the threat of persecution owed much to the example of his master. Rohault, like Descartes, was careful about what he published and made clear his submission to the authority of the church. But most important of all, Descartes' metaphysics, Descartes' method and Descartes' physical system dominated his Traité.

In the Traité Rohault briefly described the metaphysical roots of cartesian physics and because of this brevity he has been seen as having separated Descartes' physics from his metaphysics. However, in the early chapters in which he described his knowledge of the existence of his mind and of the material world, he showed that such a separation was not his intention. The mechanistic philosophy of Descartes, the ordering of the material world through an understanding of matter in motion, where matter was defined as extension and motion as local motion, lay at the basis of his work and was the foundation on which he constructed his cartesian system. He claimed that the edifice of his physics was built with the bricks of mathematical logic and moreover, could be shown to correspond with the world of physical reality. Rohault's hypotheses were not 'fictions'; both deduction and experimental corroboration were given equal weight in his methodological prescription for the sciences. Like Descartes, he attempted to use what philosophers of science have called a hypothetico-deductive method.

The elements of Rohault's methodological therapeutics and his idea of the value of physics are found not only in Descartes' works but also in the Parisian scientific milieu. Belief in the power of mathematics and rejection of slavish adherence to outworn doctrines were common among members of the scientific community. Huygens, Chapelain, Perrault and Mariotte were aware of the tentative nature of scientific enquiry. Propagandists and practitioners of a detailed, experimental study of nature encamped at Montmors' and Thevenots' and scaled new heights with the foundation of the Académie des Sciences. Pascal, Pecquet and Le Gallois believed in the progress of the sciences, Sorbière, Thevenot and Justel in their utilitarian value. Sorbière, for example, had urged Montmor's assembly, "Tendons au plustost à la pratique dans nos raisonnemens sur les causes naturelles que nous recherchons".[2] It is unlikely that Rohault failed to be influenced by ideas which were current in Parisian scientific circles.

The work of Rohault's compatriots, as well as his own technical skill and interpretation of Descartes, encouraged him to accord experiments a privileged position in his conferences and *Traité*. There are passages in the *Traité* which show that he was the follower of the work of a large number of natural philosophers. He used the observations of Galileo and Cassini, Huygens' explanation of the rings of Saturn and his experiment with Spanish wax, Pecquet's discovery of the receptacle of the chyle and the work of Pascal, Auzout and Roberval on vacua to give his *Traité* the appearance of "un atlas d'images mécaniques". He was quick, however, to interpret

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[2] *Lettres et Discours de M. de Sorbière*, p. 200.

his experiments in a way that met the logical requirements of the cartesian system. His use of a variety of sources was inspired by the practical need to keep abreast of recent developments. Nevertheless, it reflects an eclectic side to his nature, a desire on his part to unite and reconcile a variety of opinions.

Another example of this conciliatory trait of Rohault's was his matching of two incompatible philosophies, the Aristotelian and the cartesian: he delicately argued that his cartesian system did not contradict the work of Aristotle. It has been shown that no simple explanation of Rohault's deferential treatment of Aristotle is possible. His university career, his recognition of the value of Aristotle's work and of the philosophic affinity of the two systems, his belief in progress and his desire as a propagandist to win acceptance for Descartes' doctrines in schools and universities inclined him in this direction. What convinced him that he should continue along this path, however, was the increasing possibility that his work might be condemned as heretical or as 'prejudicial to the tranquillity of the kingdom'.

The persecution of cartesianism, both real and threatened, thus had its impact on Rohault's work in natural philosophy. More than anything else, it was the dangers of persecution which accounted for changes in his attitude to Aristotle and which led him to defend Descartes' interpretation of the Eucharist and away from his first love, physics. In this respect his problems were not exceptional. Censorship was one of the facts of seventeenth century life as other cartesians and members of the scholarly community like de Villon, Arnauld, de Sallo, Renaudot and the Académie des Sciences could well testify. In dealing with his opponents Rohault was as shrewd as an accomplished diplomat. He may not have been as Saverien described him, "le premier physicien moderne", but he was a staunch and ingenious defender of the cartesian faith.

Appendix 1. Genealogy of the Rohault family.

- Jehan dit 'Thinon'
  m. Guillemette Bigot
  - Ambroise Rohault écuier, Conseiller et bailli de Waben
    - Jacques Rohault bourgeois d'Amiens 14 May 1608, d. 10 Nov. 1644
      m. Marie Guillebert
      - Ambroise
        b. 1 Nov. 1590
        mercier 16 April 1619
        m. Antoinette de Ponthieu Jan. 1617
        - Jacques
          Prof. ès Maths.
          m. N. Filassier Jan. 1650
          m. (2) G. Clerselier Sept. 1664
          - Marie
        - Germain
          b. 9 Aug. 1619
          Chapelain of Dompmart
          Canon of St. Quentin
        - Marie
          b. 9 Aug. 1621
        - Jacques
          b. 23 May 1623
          Canon of St. Quentin
        - Jeanne
          b. 23 Aug. 1637
      - Hugues
        b. 4 Jan. 1593
      - Guillaume
        b. 30 Jan. 1595
      - Catherine
        b. 4 April 1603
      - Jacques
        b. 28 Sept. 1605
        Marchand Mercier of Paris
        m. Marguerite Lescuyer Dec. 1627
        - Marguerite
          m. Jacques Boutet
          Marchand Bourgeois of Paris
      - Jehan
        b. 26 Dec. 1607
      - Jehan
        b. 19 Sept. 1610

Appendix 2. Merchants, craftsmen, artisans and Rohault's *Traité de Physique*

In his *Traité* Rohault made good use of his knowledge of the techniques of artisans and craftsmen to illustrate many of his arguments. The evidence available suggests that it was through family connexions that he gained a substantial portion of such knowledge.

Craftsmen etc. with whom Rohault had contact.[1]	*Traité de Physique*
Ambroise Rohault, bourgeois d'Amiens, marchand des vins.	Wine production and the properties of taste: (Rohault, *System*, I, 24,174-7).
Philippe Filassier, marchand orfèvre de Paris.	Gold-workers and the divisibility of matter: (*System*, I, 9, 34-37). The means of separating gold and silver: (*System*, I, 22, 126). How goldsmiths make silver white: (*System*,I, 27, 221). Why gold is easy to cut: (*System*, III, 6, 155).
Michel Filassier, md. jouallier de Paris.	Diamonds and the properties of light: (*System*, I, 27, 205-6). Precious stones: (*System*,III, 7, 160-1).
Nicolas Crepet, maistre tabletier de Paris.	Tables and changeable colours: (*System*, I, 27, 252-3).
Jean Le Paultre, maistre maçon de Paris.	How water hardens plaster of Paris: (*System*,I, 22, 131-2). Lime and the properties of heat: (*System*, I, 23, 163).
Antoine Courtril, md. mirottier de Paris.	Mirrors: (*System*, I, 34).

[1] THIS LIST IS COMPILED MAINLY FROM DOCUMENTS IN THE MINUTIER CENTRAL.

Jean Le Cuntrix,
md. drapier de Paris.

The blackest thing in the world-- black-velvet: (*System*, I, 27, 223). Colours and the dyeing of cloth: (*System*, I, 27, 228-9).

Others through whom Rohault may have had access to workshops include Jacques Rohault (oncle), marchand mercier de Paris, Jacques BOUTET, md. bourgeois de Paris, Philippe Filassier (beau-frère), md. orfèvre et juré MOULLEUR de boire de Paris and Jacques GROUARD, md. jouallier de Paris.

Appendix 3

Extract from Rohault's Inventory: his books and instruments.

Ensuite Les Livres

A Scavoir Almagestum Novum auctore petra Joanus	
Babtista In follio prise trois livres dix sols cy	111"xs
Item archimedis opera In follio prise soixante sols cy	lxs
Item Francisci Vietae opera In follio prise quatre livres cy	
	1111"
Item Guidi Ubaldi opera In follio prise soixante sols cy	lxs
Item La perspective de Charles Bourgouin In follio prise	
Cinquante sols cy	ls
Item Le Traite des poids suspendues du sr Roberval	
prise quarante sols cy	xls

de diamans a chascun ung pie a l'[illegible] dix [illegible] a ses
[illegible] d'argent d'assiette une salliere a pied, ung
[illegible] ung [illegible] d'ung [illegible] vielles d'une couronne
d'or [illegible] quatre flambeaux [illegible]
a six [illegible] une Mouchette une [illegible] d'ung bassin
et ung flacon le tout d'argent [illegible] poisant
~~a quatorze marcs [illegible] livres~~
prisé le marc a sa juste valeur [illegible] vingt six
livres [illegible] a quatorze cens
soixante livres
+ Cinquante vingt Marcs [illegible] six gros

iiij^m vi^c Lx lt

Item une pandulle faicte d'argent pour l'eau. Rolland
d'une boiste d'argent dont le [illegible] de la Monstre et aiguille
sont d'argent prisee Cent livres

C lt

Item une Monstre a sonner a boiste d'ebeine d'ung
Rolland prisé Cent Cinquante livres

CL lt

Item une [illegible] monstre d'ung Rolland aussy a boiste d'or
prisé six vingt livres

vi^xx lt

Item d'ung [illegible] Monstre aussy d'ung Rolland a boiste
d'argent [illegible] d'ung [illegible] livres

ij^c lt

Item ung [illegible] de soixante dix [illegible] Baroques Moyennes
prisé quatre vingt livres

iiij^xx lt

Les [illegible] livres

En premier Almagestum Ptolemaei ~~[illegible]~~ [illegible] Joannis
Baptistae in folio prisé trois livres dix solz

iij lt x s

Item Archimedis opera in folio prisé soixante solz

Lx s

Item Francisci Vietae opera in folio prisé quatre livres

iiij lt

Item Guidi Ubaldi opera in folio prisé soixante solz

Lx s

Item Les perspectives de [illegible] Benedetti in folio prisé
Cinquante solz

L s

Item Le traicté d'une [illegible] par le sr Robinel
prisé quarante solz

XL s

Item Les portraits anathomiques de Jacques Grevin

In follio prise trente sols cy llls

Item La Theorie des planetes de Duret In follio
prise trente sols cy llls

Item Le Flambeau de la Navigation In follio prise
vingt sols cy xxs

Item Les Fortiffications du Compte de Pagan prise
Quarante sols cy xls

The next eleven items only contain references to the size and value of the volumes.

Item Les portraictz antiques de [illegible]
dix pieces prisé [illegible] solz lx s

Item La chronologie d'un [illegible] de [illegible] pieces
prisé [illegible] solz lx s

Item Le flambeau et la [illegible] de [illegible] pieces prisé
vingt solz xx s

Item La confession du [illegible] prisé
quarante solz xl s

Item ung paquet de cinq volumes de livres in quarto
cotté A prisé cinquante solz L s

Item ung paquet de neuf volumes de livres in
octavo cotté B prisé [illegible] solz lx s

Item ung autre paquet de douze volumes de livres
in octavo et in douze ~~faict~~ cotté C prisé cent solz C s

Item ung autre paquet aussy de douze volumes de livres de
plusieurs grandeurs cotté D prisé quatre livres iiij tt

Item ung autre paquet de douze volumes de livres
in octavo et in douze cotté E prisé quarante solz xl s

Item ung autre paquet de [illegible] volumes de livres aussy
in octavo et in douze ~~prisé quarante~~ cotté F prisé
quarante solz xl s

Item deux autres paquetz l'un de douze et l'autre de
[illegible] volumes de livres pareillement in octavo et in douze
cottez G et H qui ont esté prisez soixante solz lx s

Item ung autre paquet de dix neuf volumes
de livres in octavo et autres cotté I prisé six livres
vj tt

Item ung paquet de seize volumes de livres de differentes
grandeurs cotté K prisé trois livres iij tt

Item ung autre paquet de neuf volumes de livres
aussy de differentes grandeurs cotté L prisé cinquante solz L s

Item un pacquet des oeuvres de Mr Descartes en huit
vollumes In quarto Cotte N prise vingt livres cy xx"

Item un autre pacquet de Cinq vollumes de livres In quarto
de la philosophie de Regius et de la Methode dudit sr Descartes
Cotte O prise sept livres dix sols cy vll"xs

Item un pacquet de la philosofie du pere Fabry en cinq
vollumes In quarto Cotte P prise cent sols cy Cs

Item Les Fortiffications du Chevalier de Ville In
follio prise six livres cy vl"

Item Les quinze Livres des Elemens du Cledi en un
vollume In quarto prise quatre livres cy llll"

Item Apolonius Pergeus Sur Les Coniques en deux
vollumes prise six livres cy vl"

Item Le Cours Mathematique de Herigone en quatre
vollumes In octavo prise dix livres cy x"

Item optica aquilonii In follio prise cinquante sols
cy ls

Item trois Cent trente exemplaires In quarto sur
velin de La physique dudit deffunt sr Rohault prise
chacun ... quatre livres
(le tout pris) ensemble audit prix de treize cent vingt livres
cy $xlll^{c}$ xx"

Item sept Cent vingt exemplaires en blanc et sur velin
de Ladite physique In douze en 2 vollumes, prise chacun exemplaire trente
sols (le tout pris) ensemble audit prix de Mil quatre vingts livres
cy $ylll1^{c}$ "

Ensuite Les Instrumens et Curiositez servant
aux Mathematiques et pour les experiences
dudit deffunct Sr Rohault

A Scavoir un oeil artificiel de carton avec cristaux

Item vingt une paquets de six volumes de livres de différentes grandeurs non cotés prisé quatre livres cy — iiii lt

Item un paquet du commerce de Mr Descartes en quatre volumes in quarto cotés H prisé vingt livres cy — xx lt

Item six autres paquets de cinq volumes de livres in quarto de la philosophie de Digby et de la méthode de Descartes ~~prisé~~ cotés O prisé six livres dix sols cy — vi lt x s

Item un paquet de la philosophie du père Fabry en cinq volumes in quarto cotés P prisé cinquante sols cy — L s

Item les fortifications du chevalier de Ville in folio prisé six livres cy — vi lt

Item les quinze livres des éléments d'Euclide en deux volumes in quarto prisé quatre livres cy — iiii lt

Item Apollonius Pergaeus sur les coniques en deux volumes prisé six livres cy — vi lt

Item le cours de mathématique de Hérigone en quatre volumes in octavo prisé dix livres cy — x lt

Item optica Aquilonii in folio prisé cinquante sols cy — L s

Item trois cent huit exemplaires in quarto non reliés de la physique dudit défunt sieur Rohault prisé chacun ~~[illegible]~~ quarante sols revenant ensemble à [illegible] cent vingt livres cy — xvi^c xx lt

Item deux cent vingt exemplaires en blanc desdits livres de la physique dudit premier, prisé chacun exemplaire douze sols revenant ensemble à mil quatre vingt livres cy — [illegible] lt

Ensuivent les instruments et choses servant aux mathématiques et physique dudit sieur Rohault

Premièrement un [illegible] de Martin aux [illegible] prise vingt Livres cy xx''

Item un Cent de petistes larmes de verre a faire des

experiences prise huict Livres cy vlll''

Item une seringue de cuivre jaulne a faire des experiences

du vuide prisee dix Livres cy x''

Item huict pieces d'aymant deux grosses rondes six plattes

(margin avec une gondolle, vaisselle d'argent, un pied d'ivoire une

esguille de Boussolle)

prisees ensemble quatre Cent Livres cy llll^c ''

Item une Boiste d'instrumens servant a expliquer des Crics(?)

differens prisee quatre Livres cy llll''

Item un Mycroscope de Cuivre prise dix Livres

cy

Item quatre petits miroirs ardans prises ensemble

soixante sols cy lxs

Item deux prismes prises ensemble trente sols cy llls

Item deux morceaux d'ambre prises ensemble vingt sols cy xxs

Item trois petits Mycroscope de verre prises ensemble

trente sols cy llls

Item une Lantille pour grossir les objects prisee quinze

sols cy xvs

Item une boiste de Cuivre pour expliquer Les refractions

prise vingt sols cy xxs

Item un demy Cercle ou graphometre de Cuivre

de fond (imin et sur) son pied prise quarante Livres cy xl''

Item un raporteur de Cuivre prise quarante sols cy xls

Item un Compte pas de Cuivre prise six Livres cy vl''

Item un Compas a pointes qui se changent pris

trente sols cy llls

Item trois autres petits Compas prisez quarante sols cy xls

Item trois Curvelignes de Cuivre prisez ensemble

quarante sols cy xls

Item un Compas d'assier prise trois Livres cy lll'' pese vingt livres xx ll

Item ung livre d'espreuve [illegible] a faire des espreuves pese huit livres cy viij ll

Item une [illegible] de cuivre [illegible] a faire des espreuves [illegible] pese dix livres cy x ll

[illegible] d'aymant [illegible] de Boissolle

Item huit pieces d'aymant dix grosses rondes et six plattes ensemble quatorze livres cy xiiij ll

Item une boiste [illegible] pour expliquer [illegible] pese quatre livres cy iiij ll

Item ung Mycroscope de cuivre pese dix livres cy x ll

Item quatre pieces Mirouers ardans ensemble soixante sols lx s

Item deux prismes ensemble cent sols c s

Item deux Mirouers d'ambre [illegible] ensemble vingt sols cy xx s

Item trois pieces Mycroscope de verre ensemble cent sols c s

Item une lunette [illegible] sols xv s

Item une boeste de cuivre pour expliquer [illegible] vingt sols xx s

Item ung demy cercle ou graphometre de cuivre [illegible] pese quarante livres cy xl ll

Item ung rapporteur de cuivre pese quarante sols xl s

Item ung compas [illegible] de cuivre pese six livres cy vj ll

Item ung compas a pointe [illegible] cent sols c s

Item trois [illegible] compas quarante sols xl s

Item trois [illegible] de cuivre ensemble quarante sols xl s

Item ung compas d'acier pese trois livres cy iij ll

Dudit Jour de Relleve

Item un grand Miroir ardent poze sur son pied	
prise Quinze Livres cy	xv"
Item deux Boistel longues de bois de noier dans	
Lesquels sont plusieurs thuiaux a faire L'experience du vuide	
prises ensemble quarante Livres cy	xl"
Item deux Globes L'un terrestre et L'autre Celeste	
et une Sphere prises ensemble trente Livres cy	lll"

Despence de [illegible]

Item un grand Miroir ardent [illegible] prisé [illegible] livres cy — XV lt

Item deux Bouteilles longues [illegible] de verre d'une [illegible] [illegible] a faire l'experiance de [illegible] prisées quarante livres cy — XL lt

Item deux [illegible] [illegible] et [illegible] et une [illegible] [illegible] prisées trente livres cy — XXX lt

Mathi [illegible]

Le [illegible] jour de [illegible] Constance

[illegible] cinquante Louis d'or [illegible] livres [illegible] [illegible] cinquante livres cy — XV^{c} L lt

Item cinquante pistolles d'Espagne a unze livres piece [illegible] cinq cens cinquante livres cy — V^{c} L lt

Item un Somme [illegible] deux cens cinquante livres [illegible] cy — II^{c} L lt

Somme totale de ce dernier Compte deux mil ~~[illegible]~~ trois cens cinq^{te} livres

Le [illegible] du [illegible] Septembre

Premierement une expedition du Contract de Mariage d'entre [illegible] et [illegible] Rozalie de Sayve [illegible] [illegible] passé par devant [illegible] et Mirand [illegible] Mariage [illegible] [illegible] [illegible] [illegible]

Appendix 4

A) Sources consulted for details of Rohault's univerity career.

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Vols. 77/79,Livres des nominations des nations réunies,1629-57.

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Archives Nationales.

H^3 2552^c,Collège de Clermont.

H^3 2899^3,Collège d'Autun.

H^3 2785^{32},Comptes du Collège de Beauvais,1641-58.

M 91-2,Collège de Beauvais. Officiers et boursiers.

B) Sources consulted for information on Rohault's role in the 1667 celebrations.

Bibliothèque Nationale.

Mélanges de Colbert 127bis,"Clerselier à Colbert,de Copenhague, Fév. 1665" (fol. 1140).

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Fonds Français 6899,Papers of Michel Le Tellier (1661-9).

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Fonds Français 17408,Séguier correspondence,1667-7.

Fonds Français Nouvelles Acquisitions 6201,Papers of Queen Christina of Sweden.

Bibliothèque de l'Arsenal.

Mss. 4719,Letters of Chevalier de Terlon, French Ambassador in Denmark, to Arnauld de Pomponne, Ambassador in Sweden, dated 1666-8.

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Mss. 661-2,Life of R.P. Blanchart. See 662,1667 celebrations,(fols.112-3).

Mss. 712,1667 celebrations (extract from Baillet),(fol. 103).

Mss. 1152,1667 celebrations,(fol. 66).

Mss. 1856-69,Correspondence of the Genofevins,1652-72.

Mss. 1891,Journal of Pierre Lallemant,1667 celebrations,(fol. 77).

Mss. 1963,Documents concerning the Abbay of Ste. Genevieve.

Mss. 2559-64,Létters of Blanchart. See 2560,letter to Pere Asseline in Rome which mentions the 1667 celebrations,(fol. 52).

Mss. 3534,Clerselier's attestation of Descartes' orthodoxy,(fol. 3).

A list of sources

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b) Manuscripts

c) Contemporary printed sources

d) Editions of contemporary printed and mss. sources

e) Secondary sources

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L'état sommaire par séries des documents conservés aux Archives Nationales, Paris, 1891.

L'état général par fonds des Archives Départementales (ancien régime et période révolutionnaire) Paris, 1903.

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D. Gallet-Guerne, Les sources de l'histoire littéraire aux Archives Nationales, Paris, 1961.

A. Corda, Catalogue des Factums et d'autres documents judiciaires antérieures à 1790, vol. 5, Paris, 1900.

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10352, Epistolae S. Sorbière.

Fonds Français

4332, Testaments de Roys, princes et grands Seigneurs et hommes doctes, "Testament et codicille de Pierre Gassendi, 17/18 Sept. 1655" (fol.230).

6132, Catalogue de la bibliothèque de M. Thevenot.

6899-6900, Papiers d'état de Michel le Tellier, 1670-78.

10276-7, Journal de Paris.

10327/13041, Correspondance et papiers politiques et astronomiques d'Ismael Bouilliau, 1605-74.

13262, Recueil de lettres touchant le sacrement de l'eucharistie et la philosophie de Descartes, 1645-81.

14348, Journal d'Eusèbe Renaudot.

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15593, Pièces relatives à l'Université de Paris, "Arrest de la Cour de Parlement, pour les Doyens et Docteurs Regens de la Faculté de Médecine de Paris, contre Théophraste Renaudot" (fol. 581).

15963-4/16000, Lettres de Pierre Chanut.

17050, Portefeuilles du docteur Vaillant, médecin et secrétaire de Mme. de Sablé, "Pourquoy l'eau monte dans un petit tuyau" par M. de Sourdis (fol. 20).

17056, Portefeuilles Vaillant, "Sur l'Ame" par Mr de la Clausure (fol.302).

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17324, Mélanges sur l'histoire de France, "Arrest de la Cour... contre Théophraste Renaudot, 1 Mars 1644" (fol. 202).

17391/17401/17408-9/17412, Correspondance de Pierre Séguier.

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18158, "Requeste de Renaudot, pour avoir un Maistre de Requestes Commis pour faire rapport, des diverses instances qu'il avoit au Conseil, 1644" (fol. 365).

18600, Tables, ordonnances des Roys, pièces, renouvellement du Bureau, "Arrest contre Renaudot" (fol. 504). "Le renouvellement des Bureaux d'Adresse" (fol. 461).

21740, Collection N. de Lamare, "Réponse à l'Examen de la Requeste presentée à la Reine par Théophraste Renaudot. Portée a son autheur Machurat Compagnon Imprimeur" (fol. 42).

21832, Bureau de la librairie.

21945, Registre des privilèges accordés aux autheurs et libraires.

22067, Règlements de la librairie et de l'imprimerie.

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25556, Recueil de lettres et pièces littéraires du règne de Louis XIII.

26432, Mélanges pour l'histoire et la généalogie.

32585, Extraits des registres de diverses paroisses.

32827, Naissances, mariages, morts, familles parisiennes, 1630-74.

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3621, Notes pour servir à la biographie de divers personnages, extraits des anciens registres par Rochibilière.

4333, Recueil de choses diverses. A collection of anecdotes which includes references to Rohault,Descartes,Roberval,Académie des Sciences

5133-49, Académie des Sciences. Procès-verbaux des séances et du laboratoire,1667-99. Reg. par Bourdelin père et fils.

5806, Catalogus Manuscriptorum Domini de Targny.

5859-62, Ravenel. Notes Biographiques et Généalogiques.

6201, Papiers de Christine, Reine de Suede.

9706-8, Collection Lancelot. Documents Généalogiques.

9683, Documents généalogiques.

22128-9, Papiers Rochebilière/Montmerqué.

22162, Mélanges de médecine et de pharmacie, "Rohault" (fol. 74) and "Deux Lettres de M. de la Poterie à M. S. touchant la nouvelle expérience de la Transfusion du sang en la Personne d'un Maniaque, faitte à Paris,sur la fin de l'année 1667" (fol. 81).

Cinq Cents de Colbert

485, Recueil de remontrances du Parlement et de harangues de... Sorbière, Colbert etc....,"Discours de M. de Sorbière prononcé 3 Avril 1663 A l'ouverture de l'Académie des physiciens,qui s'assemblent tous les mardis chez M. de Montmor" (fol. 441) and "Lettre à Monseigneur, 25 Avril 1663" (fol. 445).

Collection Baluze

362, Correspondance bibliographique de Baluze avec Colbert...,"Lettre de l'évêque de Luçon" (fol. 26) and "Lettres de M. Chapelain à M. Colbert dans lesquelles il expose son sentiment que méditoit le ministre en faveur des arts et des sciences" (fol. 42).

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Collection Duchesne

22, Mélanges - Extraits de cartulaires, "Extrait des Registres de St. Mérri" (fol. 111).

Collection Duchesne

23, Recueil de généalogies, "Généalogie de la famille Luillier" (fol.52).

Collection Dupuy

18, Lettres de M. Bulliaud escrites à M. Dupuy St. Sauveur... 1645. 1646. 1647. 1651.

Collection de Picardie

102, Notes sur les savants et les hommes illustres de Picardie, "Hommes célèbres de Picardie" 1767 Almanach. Rohault. (fol. 68).

151, Mémoires et notes sur l'histoire littéraire, "Jacques Rohault" (fols. 171/387/394/414).

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127bis, Correspondance de février 1665,"Clerselier à Colbert" (fol. 1141)

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AD VIII 1, Edits,Arrêts,Lettres-Patentes. Académies.

AD VIII 2, Instruction Publique. Oraisons Funèbres.

AD VIII 5 Imprimerie et librairie,1630-80.

AD VIII 9^b, Ouvrages d'instruction,18e siècle.

H^3 2552, Collège de Clermont,1573-17e siècle.

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M 196, Université de Caen. Mémoires,règlements,administration,chaires d'hydrographie,de mathématiques,de physique.

M 220, Congrégation de l'Oratoire.

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M 225, Biens et affaires des collèges de Saumur,Soissons,Toulon... Vendôme.

M 230, Affaires doctrinales des P.P.Charpentier,Martin,Giraud,Lami, Pelaud et de plusieurs des collèges de l'Oratoire,1618-1793.

M 231-2, Catalogues des écrivains. Correspondance de divers pères. (Fr. de Sales,Bérulle,Terrasson).

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M 623, Annales de l'Oratoire,1611-1711.

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